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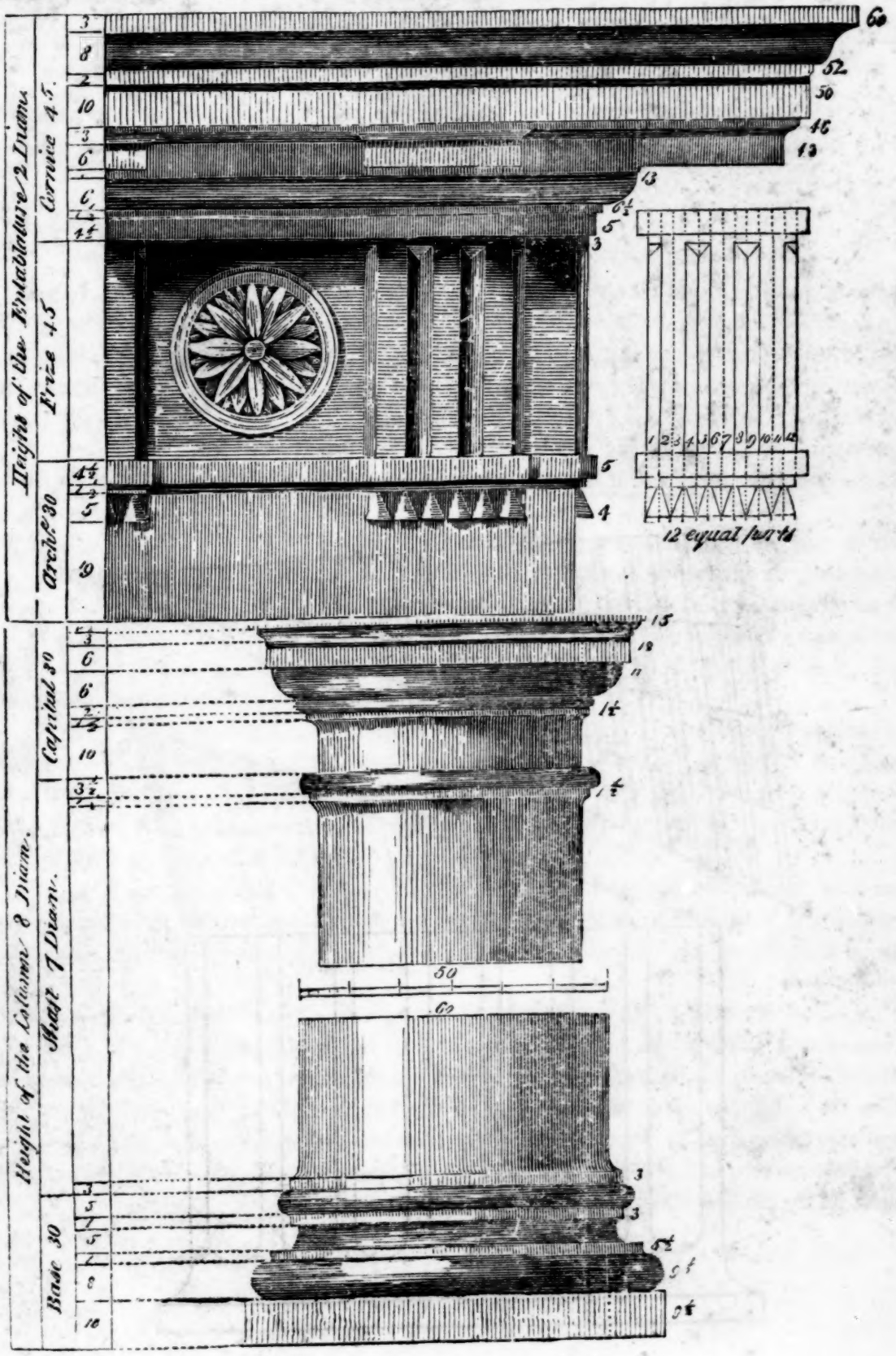
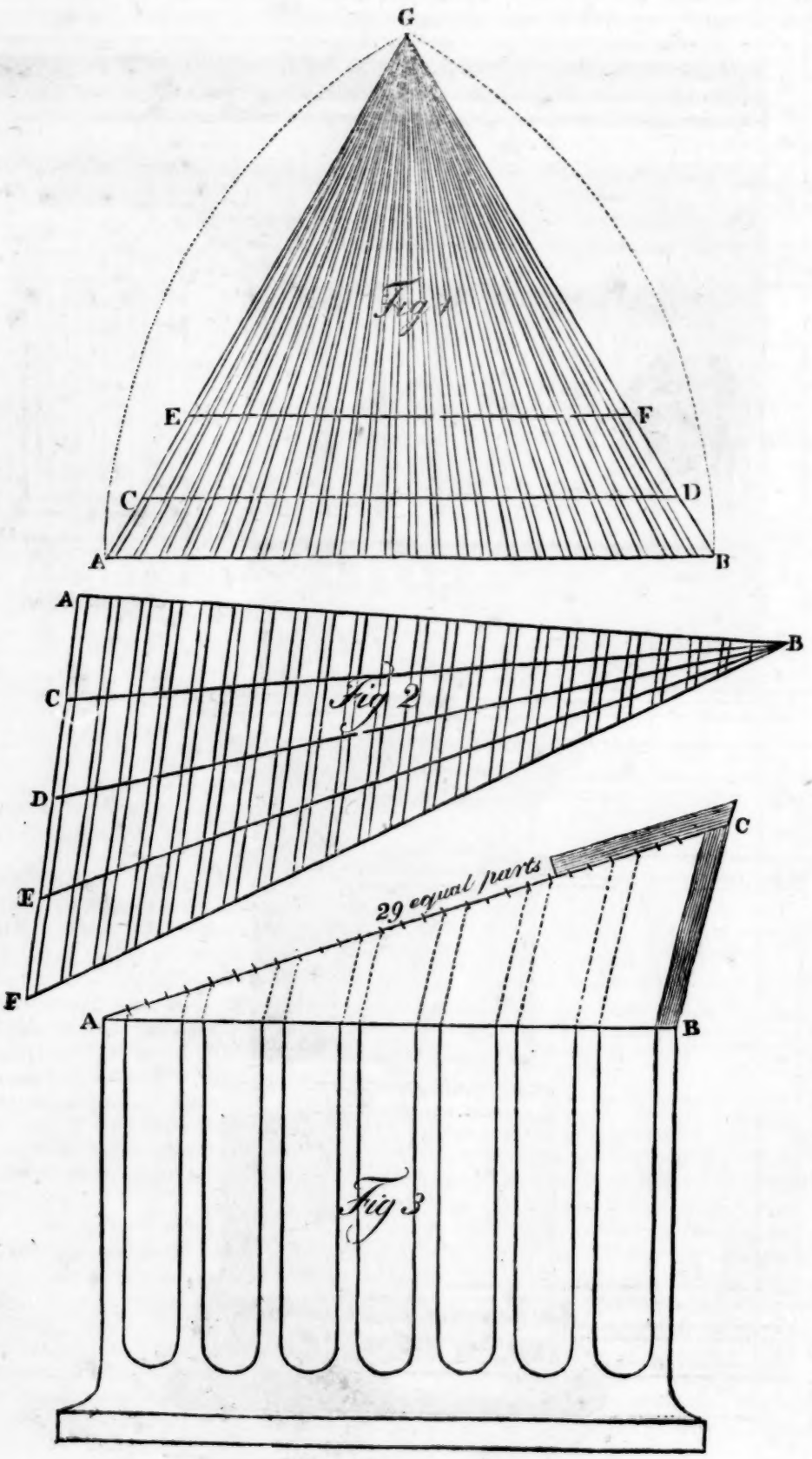


TO DRAW THE FLUTES ON A COLUMN OR PILASTER.

Plate 7.



THE STUDENT'S INSTRUCTOR

IN DRAWING AND WORKING

THE FIVE ORDERS OF ARCHITECTURE.

BY PETER NICHOLSON, ARCHITECT.

(Continued from our last.)

PLATE VII.

TO DRAW THE FLUTES AND FILLETS ON A COLUMN OR PILASTER.

Fig. 1. A B, is any line divided into flutes and fillets, greater than the circumference of the column at the base; on A B, describe the equilateral triangle A B G, draw all the points in A B to G, then if G C and G D, are equal to the circumference of the column at the bottom of the shaft, the line C D will be equal to the same circumference; lay a piece of parchment, or any thing that is pliable, on C D, and mark all the flutes and fillets on it; then apply this round the column at the bottom, and prick them round it, divide the circumference at top in the same manner as E F, and draw the flutes with a thin rule as before.

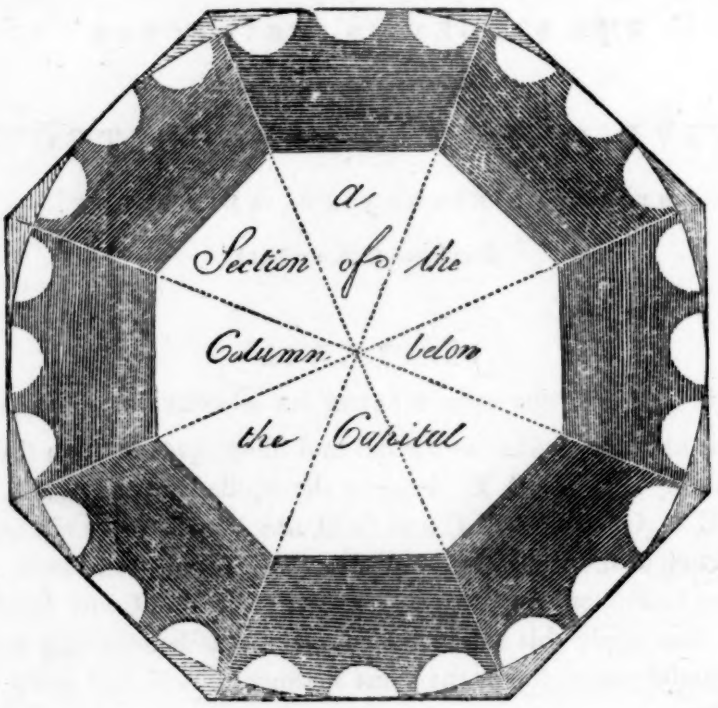
Fig. 2 is another method for marking the flutes and fillets round the end of the column; the line A B, is a line divided into flutes and fillets, less than the circumference of the top part of the column; draw any number of parallel lines from the divisions of A B, let B C, B D, B E, be the top or bottom diameter; set one foot of the compasses in B, and cross the line A F, at C D, or E, draw the line B C, B D, or B E, and either will be divided into flutes and fillets, as before.

Let A B be the breadth of the pilaster, draw any line A C; take your compasses at any convenient opening, and run twenty-nine times the said opening from A to C, and join B C; then set your bevel to the angle A C B, and from the points on A C, draw lines cutting A B, as is shown by the figure, and from the points on A B, draw the flutes and fillets with a common gauge.

There is another method of drawing the flutes of a diminished pilaster with one gauge, and at one movement, by making the gague equal to the width of the bottom, or something wider; but as this method is erroneous in its principle, no diagram is exhibited.

The best method to draw the flutes on a diminished pilaster, is to divide the height of the trunk into any convenient number of equal parts on a longitudinal line passing through the middle of the breadth at top and bottom, and through the points of division draw transverse lines to the longitudinal line: set off the flutes and fillets on each transverse line: take nails or brads in each corresponding point of each transverse line, and bend a pliable slip of wood round the nails, and draw a line, and proceed till every set of corresponding points are used, and the pilaster will have its face drawn for flutes as required.

Plate 8.



THE MANNER OF GLUEING UP THE SHAFTS OF A COLUMN.

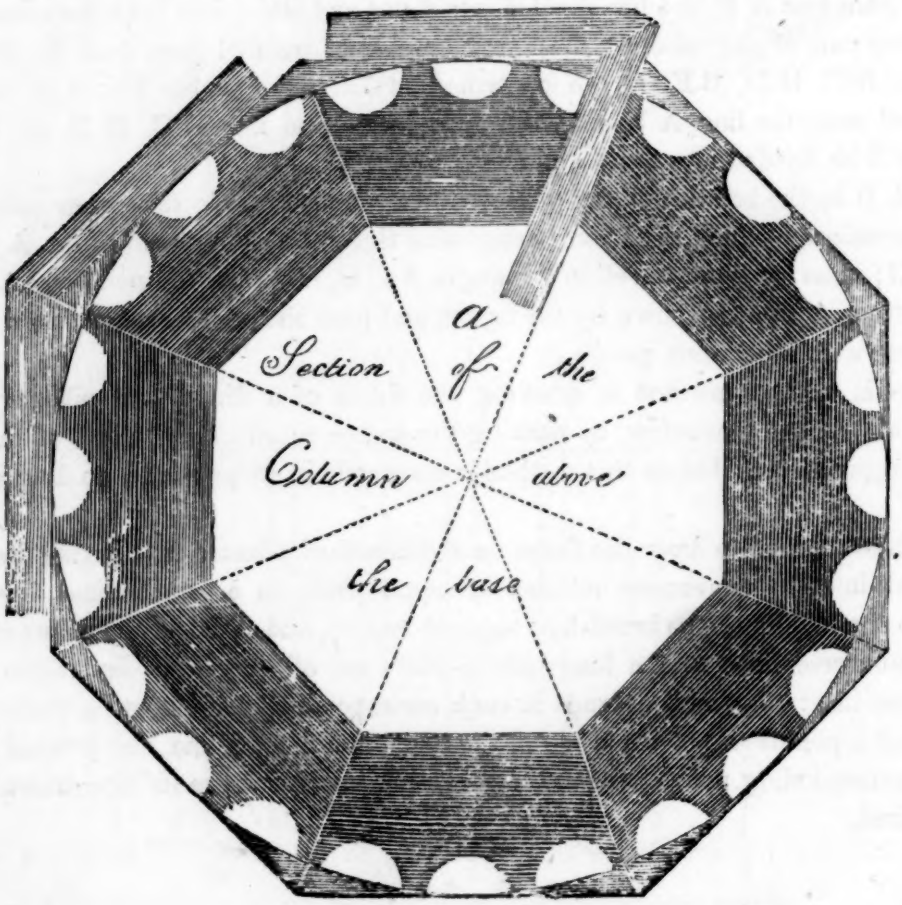


PLATE VIII.

TO GLUE UP THE SHAFT OF A COLUMN.

This must be glued up in eight or more staves, according to the bigness of the column, but always observe to have the joint in the middle of the fillet, and not in a flute, as it would very much weaken it; in this plate is shown the plan of the top and bottom ends, or the horizontal section at each end. If eight pieces are sufficient for the column, you must describe an octagon round the ends, then draw lines from each angle of the octagon to the centre, and it will give the bevel of the edges of the staves for the joints, which must be quite straight from top to bottom; only that the staves be narrower at the top, as is shown by the plans of the column; the staves must be of a sufficient thickness, because the outside is to be curved to the swell of the column, by means of a diminishing rule: then proceed to glue the pieces together one after the other; as the glue dries, block them well at the corners in the inside, which will greatly strengthen the joints: proceed in this manner to the last stave; the blocks must be glued on and dried before you can glue your last stave in: or you may glue pieces quite across for the last stave, fixed to the inside of the two adjoining staves; or by screws fix them to each stave, then the under side of your last stave must be planned so as to rub well on the cross pieces, and when the stave is put in, and glued upon the said cross pieces, you may drive it tight home like a wedge, and the whole will be as firm as possible; but care must be taken that the staves and blocks are quite dry, otherwise the column after some time will be in danger of coming to pieces at the joints; in glueing each piece, care must be taken to try it to the plan, or backing mould, as a trifling difference in each will make a very sensible error in going round the column after the glueing; when the glue in the columns is dry, you may proceed to work off the angles regularly all round; the column will then have double the number of sides, or cants; proceed in the same manner, working off the angles as before, so as to make the column have its sides or cants quite regular; lastly, make a plane to fit the curve of the column at the bottom, or rather flatter; then round off all the angles, until the surface of the column is quite smooth: there is, however, one thing I would observe in respect to the moulds for jointing the staves together; that is, they are not exactly true when applied in a direction perpendicular to the joint; the proper method to find them true is in the same manner as you will find the backing of a hip rafter, or of a pitch skylight; but, however, this exactness is not always attended to, as the deviation from the truth is so small as to be disregarded: after your column is quite finished, it ought to be well painted, to preserve it from being injured by the weather.

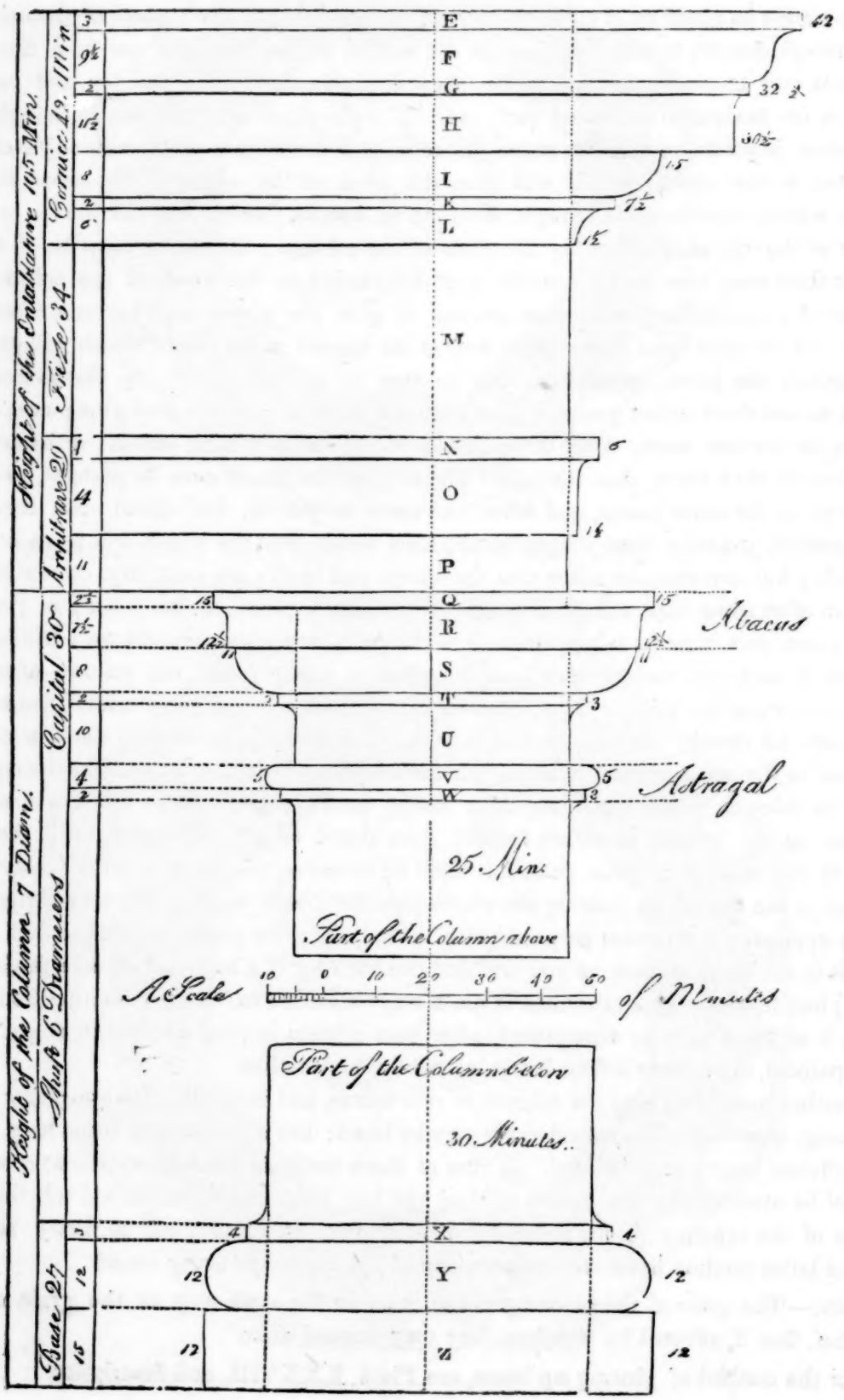
Another method is, glue the column in two halves, and then glue these together; the blockings may be put in a considerable way by hand; but if the column is too long, a rod of sufficient length may be used. Either of these methods have inconveniences which cannot be avoided; by the former method the last joints cannot be rubbed together because of the tapering of the stave, but if it is glued quickly, it will be pretty sound: by the latter method there is an uncertainty of the blockings being sound.

Note.—The grain of the blocking pieces must be the same way as the grain of the column, that if affected by weather, they may expand alike.

For the method of glueing up bases, see Plate XXXVIII, and description.

TUSCAN ORDER.

Plate 9.



OF THE TUSCAN ORDER.

PLATE IX.

TO DRAW THIS OR ANY OTHER ORDER.

Names of the Mouldings.

IN THE ENTABLATURE.		IN THE COLUMN.	
E a Fillet	In the Cornice	Q Fillet	In the Capital
F Cima Recta		R Fascia	
G Fillet		S Ovolo	
H Corona		T Fillet	
I Ovolo		U Neck of the Capital	
K Fillet			
L Cavetto		V Bead	In the Shaft
M ———	Frize	W Fillet	
N Tenia	In the Architrave	X Fillet	In the Base.
O Upper Fascia		Y Torus	
P Lower Fascia		Z Plinth	

Make a scale of the diameter of the column at the bottom; first divide it into six equal parts called modules, divide the first of these into ten, which are called minutes: then every member of the order is so many minutes of this scale, either in height or projection: the operation is as follows: draw an axis or perpendicular through the middle of the column; on this line set all your heights, or on any other line parallel to it; hten make another line parallel to the axis at the distance of twenty-five minutes, which allows five minutes on each side for the diminution at top; from this line set off your projections, as figured in the plate; for example, the projection of the top fillet E is forty-two minutes, and the projection of the next fillet G is thirty-two minutes and a half; then proceed to draw the cima recta, as already shown at Plate I, and afterwards all the other members, until you come to the base which is set off from the outer extremity of the column, that is thirty minutes from the axis.

In the Tuscan Order, the column is seven diameters high, that is seven times its diameter at the base, the entablature is one fourth of the height of the column: but if the order has a pedestal, which is seldom the case, it will be one-fifth part of the entire order in height.

To make this practice as easy as possible to the workman, the following examples will be found useful.

TO FIND THE DIAMETER OF THE TUSCAN COLUMN, WHEN THAT ALONE IS TO BE EXECUTED.

RULE.

Divide the height of the column by seven, and the quotient will be the diameter.

Example 1.

Suppose it were required to execute the Tuscan column alone, to the height of twenty-two feet, three inches, I demand the diameter of the column.

OPERATION.

7) 22 . . . 3

3 . . . $2\frac{1}{7}$

So that the diameter of the column is three feet two inches and one seventh part of an inch.

Divide 3 . . . 2 1-7 into sixty equal parts, will give a scale of minutes for proportioning the parts. The diameter, found by the following rule, in feet and inches, is always supposed to be divided into sixty equal parts, for minutes.

TO FIND THE HEIGHT OF THE TUSCAN ENTABLATURE, AND THE DIAMETER OF ITS COLUMN, THE ENTIRE HEIGHT OF THE COLUMN AND ENTABLATURE BEING GIVEN.

RULE.

Divide the height by five, and the quotient will give the height of the entablature; subtract the height of the entablature last found from the entire height, and the remainder will be the height of the column; divide this remainder by seven, as before, and the quotient will be the diameter of the column.

Example 2.

Suppose it were required to execute the Tuscan column with its entablature, to the height of twenty-two feet one inch, I demand the height of the entablature, and the diameter of the column.

OPERATION.

5) 22 . . . 1

4 . . . 5 height of the entablature.

7) 17 . . . 8 height of the column.

2 . . . $6\frac{2}{7}$ diameter of the column.

The diameter of the column being now found, it will be readily put in as follows: Suppose it were required to execute a column to two feet six inches, and two-seventh parts of an inch; take a rod of that dimension, and divide it into six equal parts, or modules, and the first part again into ten for minutes, and proceed in practice in the same manner as if you were drawing it on paper.

TO FIND THE DIAMETER OF THE COLUMN, THE HEIGHT OF THE ENTABLATURE, AND THE HEIGHT OF THE PEDESTAL, WHEN THE WHOLE IS TO BE EXECUTED TO A GIVEN HEIGHT.

RULE.

Divide the entire height by five, and the quotient will be the height of the pedestal: subtract this height from the entire height, and the remainder will be the height of the column, with its entablature: divide the remainder again by five, and the quotient will

be the height of the entablature: subtract the quotient from the first remainder, and the last remainder will be the height of the column: and this last remainder being divided by seven, will give the diameter of the column.

Example.

It is required to execute the Tuscan Order complete, with an entablature, column, and pedestal, to the height of thirty feet: I demand the height of the pedestal, height of the entablature, and diameter of the column.

OPERATION.

5) 30

6 feet, the height of the pedestal.

5) 24 height of the column and entablature.

4 . . . $9\frac{3}{5}$ height of the entablature.

7) 19 . . . $2\frac{3}{4}$ height of the column.

2 . . . $8\frac{3}{7}$ diameter of the column.

For the Mechanics' Magazine.

LABOR-SAVING INVENTIONS.

In a former number on this subject, I came, I believe, by natural inferences drawn from correct premises, to the conclusion that the various labor-saving inventions of the present day were not injurious to society; and that, instead of injuring the poor by depriving them of labor, which is their only means of subsistence, they improved their condition, by rendering their labor infinitely more profitable to the employer, and thereby not only supplying him with the means to feed and employ greater numbers, but exciting in him the stronger disposition to do it, in proportion as the profits on the work of each laborer will be greater. I stated also, in concluding the last number, that I had not done with the subject, and pledged myself not to quit it till truth and reason shall determine in favor of one side or the other.

That labor-saving inventions are injurious to the poor, by depriving them of labor, their only means of procuring subsistence, is either true, or it is not true. If not true, then the person whose deep and patient study, and whose persevering toil produces those inventions, is richly entitled to an adequate reward. But if true—if these inventions serve merely to aid the monopolizer and to oppress and starve the poor, then it is the duty of every honest man in society, not only to discountenance them, but to do all in his poweto destroy them, or at least to bring them into utter disuse.

As I have stated in a former number, the fairest way to decide this important question is to admit alternately, both sides, and on the ground of this admission, pursue each side to where it will naturally terminate, and then compare the results.

In the former number, I commenced and pursued that course, so far as relates to some of the most prominent modern inventions, such as the steamboats, canals and railroads, and the spinning and weaving by machinery. But as I have there stated, there is no stopping place: if one labor-saving invention is a curse to the poor, they are all so, and if they are a curse now, they were always curses—if any inventor of a labor-saving machine now deserves execration for so doing, every inventor, from time immemorial, was guilty of a most criminal offence, and ought to have suffered accordingly. I have already premised the destruction of the steamboats, the canals and railroads, and we will now suppose ourselves to have no other means of artificial locomotion than wheel carriages or other vehicles drawn by horses, oxen, or other domesticated animals. The entire apparatus for spinning and weaving by artificial mechanical power, we are also now to suppose destroyed or laid aside, and the farmers' wives and daughters manufacturing their own linsy-woolsy, as heretofore, with their own spinning wheels and looms.

But the case is not decided. We are to have no labor-saving machines. Not only the wheel carriages but the wheel and the loom are wicked labor-saving inventions. The carriage wheel was a most atrocious labor-saving invention; and so, ladies and gentlemen, who are riding in coaches, you must immediately disembark, and take some more harmless mode of conveyance. The invention of wheels must, no doubt, have thrown thousands of poor laborers out of employment, and left their families starving. No matter how long the offence has been committed; it is still unatoned for, and the longer it has been in use, the greater is the accumulation of guilt. The farmer, also, must, for the same reasons, discharge the wheels from his cart or wagon. If the travellers wish to be carried, they must hire poor men to carry them in a palanquin or on a litter—for they cannot now be allowed even to ride on horseback, as catching and domesticating the horse and other wild animals, and teaching them to labor, was evidently a labor-saving invention, and was transferring the labor from poor men to beasts. And if the farmer has any thing to carry to market, he must carry it himself, or employ his poor neighbors to do it. But as the farmer must now dispense with the use of the plough, the spade, the axe, and nearly all his implements of husbandry, they having all been, at some time or other, labor-saving inventions, he will, therefore, have little or nothing to carry to market.

The spinning wheel and the loom, and all the ingenious labor-saving inventions by which the various fabrics for clothing are now made, must share the same fate. Both spinning and weaving were once performed, and in several parts of the world are still performed, in ways which would give employment to fifty poor people to do what would now be done by one wheel or one loom.

When we have brought the traveller, the farmer and the manufacturer of articles for clothing, to a proper sense of their duty, and they have discarded all those hateful monopolizing inventions, by which the poor are doomed to idleness and starvation, let us next turn our attention to that most pernicious of all other inventions, the printing press. So base a thing was this encroachment upon the ancient rights of those worthy people who obtained a respectable living by writing books, or rather long rolls of parchment, that the inventor was declared not only to be moved and instigated by the devil, but in absolute league with him, and was dealt with accordingly. When we have destroyed the press, the next business in course will be to destroy all the printed books, in order to restore business to those who would be employed to write them, as they were formerly, in manuscript rolls. And when we have done all this; when we have not only destroyed the press and its productions, but all the labor-saving machines and implements of the farmer and the manufacturer, let us review the subject, and see what will be the state of society, and what benefits will result to the poor.

In this state of things, labor of the most industrious man would not yield him one half of what we now consider the necessaries of life. The rich, so long as they remained rich, would indulge themselves in the comforts and luxuries of life, but they would have to import them from foreign countries, for they could not be made here; and as they would have nothing to export but cash, their wealth would be constantly diminishing. They could not afford to cultivate their lands any farther than was necessary to a bare subsistence, because nothing they could produce would pay the cost of producing. They could not let out their lands to the poor to work either on shares or on hire; for the whole of what the poor man could raise would scarcely keep himself and family alive, and he would have no means to pay rent, and therefore could not hire. In a few years, the land, but little of which could be cultivated, would become useless, except for hunting ground; the rich would become poor, and the poor would become inured to want and hardships. In a very few centuries, the country would be in the same state the aborigines were in when this country was discovered. In short, the whole ground by which this or any other civilized country differs from the state in which aboriginal America was discovered, is solely the result of labor-saving inventions.

The advocates of the anti-labor-saving doctrine will perhaps say, "This is a mere assertion, we want better proof, before we can be convinced." I will endervor, then, to give the best proof the nature of the case will permit, and I think the best they can possibly require. "Facts are stubborn things," and to their decision I will refer each part of the subject. I shall begin with the modes of conveyance of persons and property, and proceeding to modes of agriculture and modes of manufacturing, shall appeal to examples in each case, to show what has been the effect of labor-saving inventions.

With respect to travelling and conveying property, every thing that relates to it naturally comes under the same head. An improved public road, a turnpike road, a railroad, a canal, or a steamboat, are all equally entitled to be classed as labor-saving inventions. In each of these, our own country affords innumerable illustrations of the effect they have in giving labor to the poor, rather than taking it away from them. In constructing turnpikes and railroads, and in digging canals, more laborers have been employed and paid in the United States, within thirty years, than were ever employed in this country before, since its first settlement; or than would be employed in one or perhaps two centuries to come, had no such work been undertaken; and could any mode be contrived to increase the effect of

such labor—could any means be invented by which one man could remove as much earth in a given time as two can now remove; instead of lessening the number of laborers, it would increase them, because in proportion as such improvements could be effected cheaper, many more would be undertaken. Before the Erie Canal was commenced, such works were by most people in our country, as well as in most others, considered visionary and impracticable. The chief demand for labor then, was to aid the farmer who had a little more land than he and his sons could till; and who happened to live near some city or seaport, where his produce would command money to pay for such labor. If he lived far from market, his effects would not pay for carrying to market, and therefore he could not hire. Now, hundreds of thousands of laborers are employed in constructing public improvements; and those improvements not only increase the demand for provisions, as the laborers must all be fed, but they open a market to the most remote farmer, and thereby increase the demand for agricultural labor.

In the year 1827, the clamors of laborers and others against labor-saving improvements, attracted the attention of the British House of Commons, and a committee was appointed to investigate the subject. From their report I shall offer some extracts, which I think, if any doubts remain on the subject, after what evidence this country affords, must remove them.

"In the Highlands of Scotland, at the beginning of the present century, the communication from one district to another was attended with such difficulty and danger that counties were excused from sending jurors to the circuit, to assist in the administration of justice. The poor people inhabiting those districts were certainly cut off from intercourse with the rest of mankind. The Highlands were of less advantage to the British empire than the most distant colony. Parliament resolved to remedy the evil; and accordingly, from 1802 to 1817, the sum of two hundred thousand pounds was laid out, in making roads and bridges in these mountainous districts. Mark the important consequences to the people of the Highlands, as described by Mr. Telford, the engineer of the roads."

"In these works, and in the Caledonian Canal, about three thousand two hundred men have been annually employed. At first, they could scarcely work at all; they were totally unacquainted with labor; they could not use the tools; but they have since become excellent laborers; of that number we consider one fourth annually left us, taught to work. These works may be considered in the light of a working academy, from which eight hundred have annually departed, improved workmen. These men either returned to their native districts, having had the experience of using the most perfect sorts of tools and utensils, (which alone cannot be considered as less than ten per cent. on any labor,) or they have been usefully disseminated throughout other parts of the country. Since these roads have been made accessible, wheelwrights and cartwrights have been established, the plough has been introduced, and improved tools and utensils are used. The plough was not previously used in general; in the interior and mountainous parts they frequently used crooked sticks with iron on them, drawn or pushed along. The moral habits of the great mass of the working classes are changed; they see that they may depend on their own exertions for support; this goes on silently, and is scarcely perceived, until apparent by the results. I consider these improvements one of the greatest blessings ever conferred upon any country."

"There are many parts of Ireland which sustain the same miseries and inconveniences from the want of roads as the Highlands of Scotland did at the beginning of the present century. In 1823, Mr. Nimme, the engineer, stated to Parliament that the fertile plains of Limerick, Cork and Kerry, were separated from each other by a deserted country, presenting an impassable barrier between them. This country was the retreat of smugglers, robbers and culprits of every description. According to another engineer, Mr. Griffith, this tract, in 1824, was a wild and deserted country, without roads, culture or civilization. The govern-

ment ordered roads to be made through this barren district. In 1829, in less than five years after the commencement of the roads, Mr. Griffith thus describes the change that had been produced:

"At the commencement of the works the people flocked into them, seeking employment at any rate; their looks haggard, their clothing wretched; they rarely possessed any tools or implements, beyond a small, ill-shaped spade; and nearly the whole face of the country was unimproved. Since the completion of the roads rapid strides have been made. Upwards of sixty new limekilns have been built; carts, ploughs, harrows, and improved implements have become common; new houses of a better class have been built, new enclosures have been made, and the country has become perfectly tranquil, and exhibits a scene of industry at once pleasing and remarkable. A large portion of the money received for labor has been husbanded with care, and laid out in building substantial houses, and in the purchase of stock and agricultural implements; and numerous examples might be shown of poor laborers, possessing neither money, houses nor lands, when first employed, who, in the past year, have been able to take farms, build houses, and stock their land."

Another witness, Mr. Kelly, thus describes their condition, before and after the roads were made—"At Abbyfeale and Bransa, above half the congregation at mass on Sundays were barefoot and ragged, with straw hats of their own manufacturing, felt hats being worn only by a few. Hundreds, or even thousands of men could be got to work for sixpence a day, if it had been offered. The farmers were mostly in debt, and many families went to beg in Tipperary and other parts. The condition of the people is now very different; the congregations at the chapels are now as well clad as in other parts; the demand for labor is increased, and a spirit of industry is getting forward, since the new roads have become available." * * * * * * * * "But there are people who can understand the value of a road, who cannot perceive that of a steam-engine. Let us see what the steam-engine does for communication."

"The establishment of steamboats between England and Ireland has greatly contributed to the prosperity of both nations. How have steamboats done this? They have brought the people closer together. They have made the closely packed millions of people who live in the country round Liverpool, the neighbors of the small farmers and peasants who live amongst the rich valleys of Ireland. The steamboat has given cheaper food and more of it to the manufacturers on the banks of the Mersey, and cheaper clothes and more of them to the laborers on the banks of the Shannon."

Mr. Williams (who gave his evidence last year to Parliament on the condition of the poor people in Ireland) says—"Before the steamboats were established, there was little trade in the smaller articles of farming production, such as poultry and eggs. The first trading steamboat from Liverpool to Dublin was set up in 1824. There are now 40 such boats between England and Ireland. The sailing vessels were from one to two or three weeks on the passage. The voyage from Liverpool to Dublin is now performed in fourteen hours.

Many millions of eggs, collected among the very poorest classes by the industry of women and children, are annually sent from Dublin to Liverpool. Mr. Williams has known fifty tons, or eight hundred and eighty thousand eggs shipped in one day, as well as ten tons of poultry; and he says this is quite a new creation of property. It is a creation of property that has a direct tendency to act upon the condition of the poorer classes in Ireland; for the produce is laid out in providing clothes for the females, and children of the females, who engage in rearing poultry and collecting eggs. Thus the English manufacturer is bettered, for he has a new market for his manufactures, which he exchanges for cheap provisions; and the dealer in poultry and eggs has a new impulse to this branch of industry, because it enables him to give clothes to his wife and children.

I might extend the quotation of facts in evidence of the benefits resulting to the

poor from the introduction of labor-saving inventions, almost to infinity; but the mind that would not be convinced by what I have already said and what I have quoted, would not be so by any means short of miraculous interposition. I shall in my next number endeavor to show from reasoning, and from facts, what have been the effects of such inventions in the manufacturing interest, as to depriving the poor of labor, or of increasing their labor and benefitting their condition. S. B.

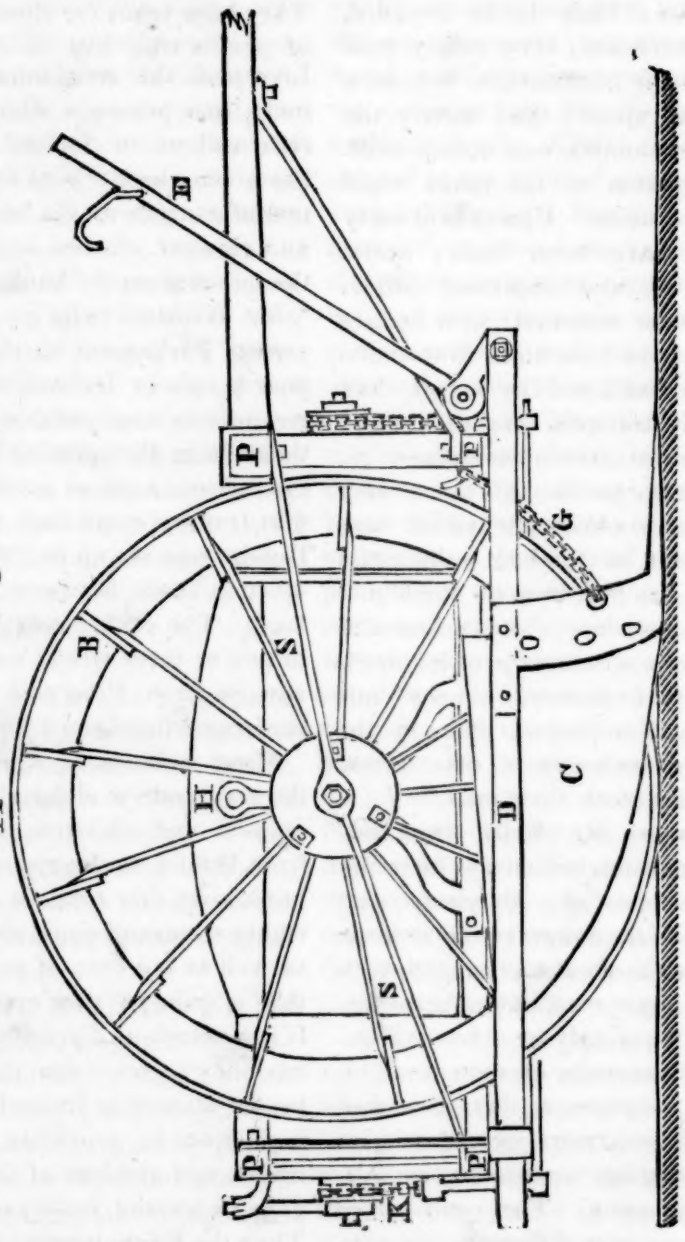


Fig. 1.

From the London Mechanics' Magazine.

PALMER'S PATENT EXCAVATING AND SELF-LOADING CART.

In this railway age, an invention which is represented to be capable of effecting a saving of no less than "500 per cent." in the time and labor attending those fundamental railway operations, cutting and embanking, will be readily allowed to be one deserving of all possible attention. Whether so prodigious a saving could be actually realised by the apparatus we are about to describe, practice only can determine; and, for the present, we are inclined to think that to expect so much from it, is to take rather a sanguine view

Fig. 2.

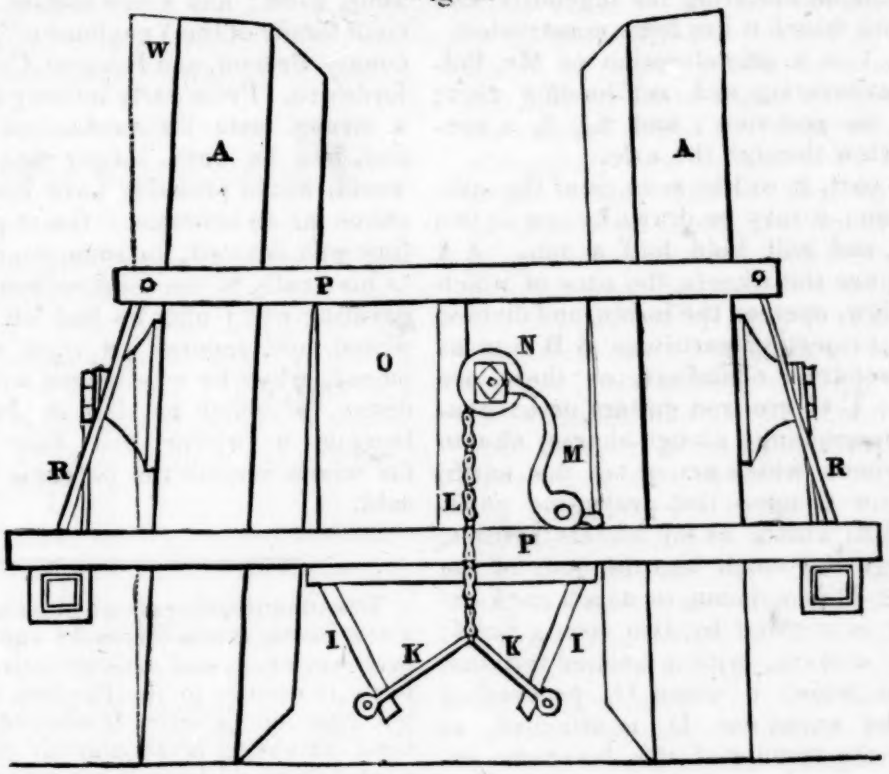
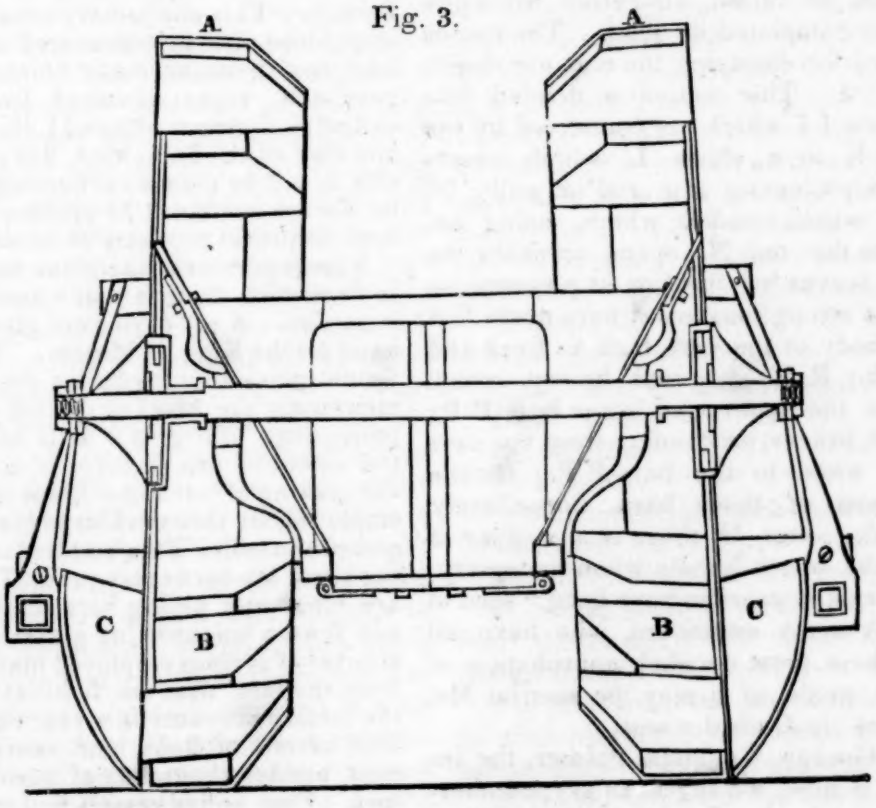


Fig. 3.



of its capabilities. But we are sure every mechanical reader will join with us, at all events, in admiring the ingenuity and skill with which it has been constructed.

Fig. 1 is a side-elevation of Mr. Palmer's excavating and self-loading cart; fig. 2, an end-view; and fig. 3, a sectional view through the axle.

The cart, it will be seen, is of the ordinary size; it may be drawn by one or two horses, and will ho'd half a ton. A A (fig. 2) are the wheels, the rims of which are hollow, open on the inside, and divided by the projecting partitions B B into as many separate chambers, as there are spokes; C C are iron cutters or excavators, resembling plough-shares, one to each wheel, which scoop out the earth, and throw it upon the projecting partitions B B, which, as the wheels revolve, discharge the earth into the body of the cart H; D is a beam, to which each excavator is secured by two strong bolts; and E, a lever, with a hooked termination, to which a chain G, proceeding from the excavator D, is attached, so that by the turning of this lever the excavator may be adjusted to any depth required, or raised altogether when the cart has completed its load. The means provided for emptying the cart are shown in fig. 2. The bottom is divided into two parts I I, which are connected by the bars K K to a chain L, which passes round a projecting iron rod or pully N. M is a winch-handle, which, being applied to the rod N, opens or shuts the bottom leaves of the cart at pleasure.—P P are strong horizontal bars made fast to the body of the cart, both in front and at back; R R, diagonal braces, which connect the upper and lower bars P P; and S S, braces, proceeding from the nave of the wheel to the bars P P. On the uppermost of these bars, immediately above the letter O, there is a stopper to retain the winch-handle when necessary.

The cart is stated to have been "seen at work by many engineers, who have all given their most decided approbation of it." A model of it may be seen at Mr. Hendries', in Oxford-street.

Mr. George Vaughan Palmer, the inventor, is now, we regret to say, numbered with the dead. In a slight biographical notice of him, with which we have been favored by a friend, it is stated that he was a native of Worcester, where he was born, June, 1786; and a descendant of the ancient family of the Vaughans of Trebaried, county Brecon, and Hargest Court, Herefordshire. From early infancy he evinced a strong taste for mechanical pursuits; and, had he been longer spared to the world, would probably have risen to eminence as an inventor. Great part of his time was devoted, for some years previous to his death, to the construction of his excavating-cart; and he had but just completed, and secured his right to it by a patent, when he was seized with a rapid decay, of which he died in June, 1834, leaving a widow and four children, for whose benefit the patent is now to be sold.

The manufacture of cut glass has, within a few years, much increased and improved in this country, and articles little if any inferior in quality to the English, are turned out from our factories in abundance. The most extensive establishment is at Sandwich, Massachusetts, a statistical description of which is given in the Barnstable Patriot. This one factory consumes *weekly* of pig lead, first manufactured into oxide of lead, ten thousand eight hundred pounds; pearl-ash, eight thousand five hundred; saltpetre, fourteen hundred; silex, ten tons; and clay, of the finest kind, five tons. From this it will be seen what heterogeneous materials are combined to produce one of the most beautiful products of human art.

A large portion of the glass manufactured in Sandwich finds a ready sale in foreign countries. A set of rich cut glass is now in hand for the King of Muscat. The demand for cut glass door knobs,—a great improvement upon the brass or plated,—is yearly increasing. To give a still fuller idea of the extent of this factory, it is stated that the making of packages keeps many hands employed, six thousand large casks being required annually. Two hundred tons of packing straw are used every year. Two packets are constantly plying between the factory and Boston transporting glass ware. The number of persons employed may be inferred from the fact, that the families attached to the factory consume in a year eighteen hundred barrels of flour, and nearly as much corn, besides thousands of bushels of potatoes. Four or five vessels find constant employment in bringing Richmond coal to the works.

Applications of Chemistry to the Useful Arts, being the substance of a Course of Lectures delivered in Columbia College, New-York, by James Renwick, Professor of Natural Experimental Philosophy and Chemistry.

III.

SALTS OF COMMERCE.

1. COMMON SALT.

The sources whence common salt, (*chloride of sodium,*) is derived, are, the water of the ocean; salt springs, which are found issuing from certain geological formations; and beds of rock salt. The two former may be separated from the salt they hold in solution, either by spontaneous or by artificial evaporation.

MANUFACTURE OF SALT FROM SEA-WATER BY SPONTANEOUS EVAPORATION.

AUTHORITIES.—FOURCROY. Traite de Chimic.
DUMAS. Chimic appliquee aux arts.

There are some warm and dry climates where, from these favorable circumstances, salt is formed by spontaneous evaporation from natural basins, which have an occasional communication with the sea at the highest state of the tides. From such basins it is only necessary to rake out the salt as it forms from time to time at the surface. In less favorable climates, artificial salt-pans are formed by embanking portions of salt meadow, and dividing the embanked space, by dykes, into a number of basins, into which the water being successively admitted, and caused to expose a large surface, is finally evaporated. The first basin is of considerable size, and serves as a reservoir, receiving water from the ocean at spring tides, and retaining it for use. From this reservoir the salt water is conveyed into the first of a series of rectangular basins, called *beds*, by a tube laid under ground. This tube enters at the corner of the first bed, and is directed by the arrangement of the openings in the separating dykes, diagonally across each of them to the end of the series. From the last bed it is passed by another subterranean tube into an open canal, which is directed in such a manner as nearly to enclose a square. The tube is admitted at one of the angles of this square, and the channel drawn from it around the square until it comes again into a basin, which is separated from the first branch of the canal by a dyke. This basin is the first of a second series, of the same extent as the first series, which go by the name of *tables*. After traversing the tables, the water passes by a short canal into a larger basin, called the *muant*, along two sides of which are arranged a number of smaller ones, in two rows, called the *areas*. These have floors of clay or plaister impervious to water. Canals are formed in such manner that each leads the water from the muant towards the common corner of four of the areas, but is still separated from them by their surrounding dykes. A temporary communication being made with these canals, the water is permitted to flow upon the areas to the depth of about an inch, after which the entrance is stopped. In these areas the salt begins to crystalize at the surface, and as soon as a crust is formed it is broken up, and either finally raked out, or removed after the whole of the water is evaporated to dryness. In the former case the salt is tolerably pure, in the latter it is bitter and disagreeable; nor could it be advantageously disposed of, were it not that the use of it is compelled in countries where salt is a government monopoly. The object of the complex arrangement of canals and basins, as we have described it, is, that when the operation is in regular train, the water, in its passage from the reservoir to the areas where the evaporation is completed, shall expose a large surface to the air, and at the same time have such a degree of motion as may bring it regularly in contact with fresh air. The arrangement of a set of salt pans may be understood from the annexed plate.

A, reservoir.
BBB, beds.
CCC, canal enclosing a square space.
DDD, tables.
EEE, muant.
FFF, areas.
gg, subterranean communication between the reservoir and the beds.
hh, do. between the beds and canal.
ii, canals, each of which conveys water from the muant to the common angle of four of the areas.

It is proper that the pans should be placed in such manner as to receive most advantageously the currents of the principal winds.

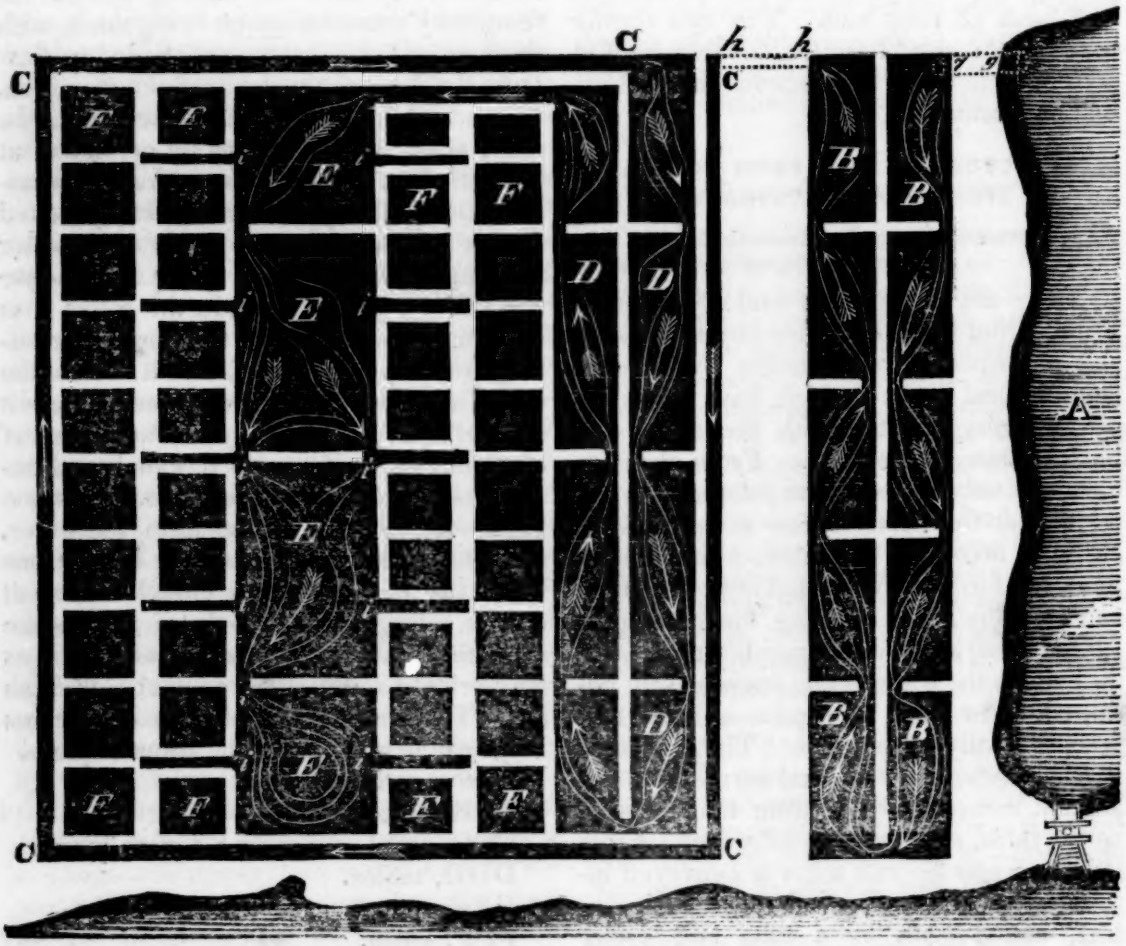
In the north of Europe the use of such salt pans begins early in March, and may continue until the end of September. The

water which is first admitted into the areas, remains for eight days before it is completely evaporated. The next charge will take a less time, for the water in the beds, tables, &c., will have been somewhat concentrated; and at the height of the season, the areas may be changed daily.

The salt raked out of the areas is piled on the neighboring ground in pyramidal heaps, where it is permitted to drain, in order to separate the water which adheres, with such matter as it holds in solution, and it attracts water from the air, which dissolves a certain soluble and deliquescent substance which, as we shall see, is contained in sea-water. These heaps are thatched with straw or bushes, in order to prevent the entrance of rain.

The salt manufactured by spontaneous evaporation, even under the most favorable circumstances, is not as pure as some other descriptions, but has the advantage of being formed in regular cubic crystals, which makes it better fitted for keeping

PLATE I.



meat and curing fish than any other description. Such salt is imported into this country in large quantities from Spain and Portugal, from Turk's Island, and the Cape de Verds. A large natural salt pan also exists within our own territory at Key West.

The impurities of which we have spoken are contained in sea-water, and are but partially separated in the process, or the subsequent draining. In 100 pts. by weight of sea-water, there are dissolved about 3 1-2 of solid matter. This matter, obtained by rapid evaporation to dryness, is composed of

Common salt,	2.54	72.
Chloride of magnesium,	0.35	10.
Sulphate of magnesia,	0.58	16.
Carbonates of lime and magnesia,	.02	00.67
Sulphate of lime,	.01	00.33
	3.50	100.

Of these substances, the carbonates of lime and magnesia being held in solution

by excess of acid, will be deposited in warm weather in consequence of the escape of the acid when a large surface is exposed to the air. The sulphate of lime being but sparingly soluble, will, after the few first days of the process, be left behind in the tables, &c., before the water reaches the areas. It will also determine the conversion of a part of the sulphate of magnesia into sulphate of soda; the latter will unite with the sulphate of lime to form a double salt. The remaining sulphate of magnesia, having a solubility in cold water about one half more than that of common salt, but being not much more than one-fifth in quantity, will not begin to crystalize until more than six-sevenths of the water which remains after the salt begins to crystalize is evaporated. Up to this time, then, the salt, if well drained, would be nearly pure. The chloride of magnesium is deliquescent and highly soluble; it will therefore not begin to crystalize until after the sulphate of magnesia, and the discharge of the water that remains after the first appearance of the bitter taste of the sulphate in the salt, will carry off both, except what may adhere mechanically to the crystals. Even if a part of the chloride of magnesium have been formed in the solid state, it may be separated in consequence of its deliquescence, by virtue of which it will attract moisture from the atmosphere, and this moisture will also dissolve some of the sulphate of magnesia. This moisture is separated by permitting the salt to drain.

So far as mechanical impurities adhering to the crystals are concerned, the salt formed in large crystals by spontaneous evaporation, is superior to all others, for it will expose a less surface under equal weight. These impurities, if deliquescent, will be also much more easily removed.

The best salt manufactured in this manner contains 95 per cent. of chloride of sodium, while that made at an unfavorable season has not more than four fifths of its weight of true marine salt, and upwards of 7 per cent. of sulphate of magnesia.

MANUFACTURE OF SALT FROM SEA-WATER BY CONGELATION.

When water holding but little common salt in solution, is exposed to a temperature below freezing, the water is separated into two parts, one of which is nearly pure, and passes into the state of ice, the other remains liquid and retains the whole of the salt in solution. As the temperature decreases, a further separation takes place, until the liquid becomes highly concentrated, and the soluble matter may be obtained at a small expense of fuel by artificial evaporation. This method is used in the northern and eastern parts of Siberia, but the salt obtained is of inferior quality,—although not necessarily so, were the process skillfully conducted.

Note.—Both of the above methods are practicable in the northern and eastern parts of the United States. Our summers and autumns would give us at least six months of weather in which the evaporation by exposure to the sun and air might be successfully practised, and if our spring be less advantageous for the purpose than those of the south of Europe, this is more than compensated by the superior dryness and steadiness of our autumnal climate. Our winters, also, equal in cold those of the same latitude in eastern Asia, and the method of congelation might no doubt be applied to advantage. Salt is manufactured on the shores of Massachusetts Bay, but we are under the impression that the evaporation is performed by artificial heat.

MANUFACTURE OF SALT FROM SEA-WATER BY ARTIFICIAL EVAPORATION.

This manufacture is generally conducted on a small scale, and with little skill, and it is only under peculiar circumstances that it has been profitably pursued. Thus the fishermen of the shores of Scotland are permitted to use salt manufactured on the spot, free from the heavy excise with which it is loaded in other parts of the kingdom. It appears probable that their art consists in little more than evaporating salt water almost to dryness in iron kettles, for the product obtained is extremely impure.

A tolerably pure salt is manufactured in the north of France from sea-water, which has been filtered through sand that has been thrown up by the sea beyond the usual reach of the tides, and which is also within reach of the spray. As the water evaporates from this, it remains charged with various proportions of solid salt. The liquid, after passing through the sand, usually has a density of 1.14, but sometimes as much as 1.17. It is evaporated in leaden vessels, and boiled rapidly over a wood fire. The

liquid rises into froth, and must be continually stirred to prevent it from boiling over. The surface is occasionally cooled by throwing on cold brine, in order that a scum which forms may be skimmed off, until the salt begins to crystalize. The evaporation is continued until the whole of the water is driven off, the solid deposit being continually stirred, in order to prevent the lead of the boiler from melting. The salt thus obtained is in fine powder, but is still very impure. In order to separate the soluble impurities, the salt is put into baskets, which are suspended over the boilers while the succeeding evaporation is going on. It is thus exposed to the action of a large quantity of steam, which penetrating between the crystals is condensed, and dissolves the deliquescent impurities along with other soluble matters, and a portion of common salt. The salt is then permitted to drain by placing it on a floor covered with sand, whence the salt has been obtained by filtration. Here it loses about 25 per cent. of its weight by drainage. The salt is then of a fine grain, white color, and agreeable taste.

The coarse or bay-salt, which is formed in large crystals by spontaneous evaporation, is best suited, as has already been stated, for curing meat, in the dry way, and particularly for packing fish. In the latter process, the cavities whence the entrails of the fish have been removed, are filled with the salt, and the barrels are filled with alternate layers of salt and fish. The only solvent is the liquor which exudes from the fish, and it appears that the more slowly this is drawn off by the salt the better. The capillary attraction of fine salt would render this process too rapid. But the salt of Spain and Portugal, and still more of France, although well crystalized, is far from pure. The inhabitants of Holland, therefore, to whom the fisheries are a most important object of national industry, subject the imported bay-salt to a process of purification.

For this purpose, it is dissolved in sea-water, and evaporated at a moderate heat; the evaporation being rendered more slow by covering the large shallow pans of sheet-iron in which it is heated, with planks.

It is to the great care that is taken in the preparation of this salt that the very superior quality of the fish cured by the Dutch is, in a great degree, owing. They also kill and clean the fish the instant it is caught, on which account it is better than that which is permitted to die in consequence of a change of element.

In the curing of meat, also, it cannot be questioned that the method of rubbing and packing in dry salt in large crystals is much to be preferred to steeping in a pickle prepared by dissolving salt.

SALT FROM SALT SPRINGS.

AUTHORITY.—DUMAS. Traite de Chimie.

More attention has been paid to the manufacture of common salt from salt springs, by scientific men, than to any other of the sources whence this article has been obtained. The salts obtained by analysis from several springs are, besides the chloride of sodium, chloride of magnesium, sulphate of magnesia, carbonate of lime, and sometimes carbonate of iron. Together they make up abont 16-1000th parts of the weight of the water of the spring of Moutiers, and are in the following proportions, with the exception of the carbonate of iron, which is deposited as soon as the water is exposed to the air:

Carbonate of lime,	0.05 per ct.	3.125
Sulphate of lime,	0.27	16.875
" of magnesia,	0.06	3.625
" of soda,	0.13	8.125
Chloride of sodium,	1.06	66.25
" of magnesium,	0.03	2.000
	1.60	100

These waters, as well as those of the sea, contain also the iodides and bromides of magnesium.

Rationale.—When the process of boiling this water is followed with attention, it is found that one fourth part of the water has been evaporated and the density increased to 1.14, before the sulphate of lime begins to be deposited. The deposit then gradually increases until 5-6ths of the water has been evaporated, after which it begins to diminish, and when 17-20ths of the water has been evaporated, ceases altogether. The deposit, when examined, is composed of sulphate of lime and sulphate of soda, in nearly equal proportions, forming in fact a double salt, and nearly as much common salt as of both united. At a density of 1.23, when abont 9-10ths of the water has been evaporated, common salt begins to crystalize at the surface, if the action of the fire be moderate; if not, it will also be

precipitated. The salt which crystalizes first is nearly pure, but gradually becomes less so, and is finally affected by a bitter taste, arising from the sulphate of magnesia. If the evaporation be stopped as soon as this taste becomes sensible, there remains a thick viscid liquid containing a portion of common salt, along with chloride of magnesium, sulphate of soda, and the iodides and bromides of magnesium. A farther quantity of common salt may be obtained even from this, by the aid of lime. This earth decomposes the chloride of magnesium, and a chloride of calcium results; the latter chloride and sulphate of soda are incompatible, so that a double decomposition results, by which chloride of sodium and sulphate of lime are formed; the greater part of the last of these is precipitated in consequence of its small degree of solubility. By farther evaporation, not only the chloride of sodium thus formed, but a part of that which previously existed, is obtained free from the bitter taste of the sulphate of magnesia, and chloride of magnesium, and from the deliquescent character of the latter. This mode of getting rid of the chloride of magnesium, which is the most injurious both to the taste and value of the salt, might be used to great advantage in all cases, and it is only unfortunate that the chloride does not exist in sufficient quantities to admit of the decomposition of the whole of the remaining sulphate of soda.

Process.—The mode of obtaining salt from the salt springs of the continent of Europe is in strict conformity to the principles deduced from the preceding observations. About 9-10ths of the water, of the density of 1.01, are usually evaporated by exposure to air.

This spontaneous evaporation is performed in three different ways, by that of hurdles; that of tables; and that of cords. The advantages of these are nearly equal, if we have regard to the quantity and quality of the salt, and the rate at which it is crystalized; the only consideration then is their relative cost in different places.

In the first method, hurdles or bundles of twigs of a thorny shrub are piled in open frame buildings covered by a roof. The water is pumped up to the top of these buildings and then distributed in small streams upon the upper course of the bundles of twigs. The direction of these buildings is such that the principal prevailing winds may be at right angles to their length; and the gutters which convey the water are so formed, that it may be distributed in greatest abundance on the windward side. The water having fallen over one series of hurdles, is again pumped up and falls over another series in the same building, until it has descended nine or ten times.

In the method of cords, the water is made to trickle over ropes stretched in a vertical direction from the upper beams of an open frame building to a basin which receives it beneath.

In the method of tables, a number of shallow wooden troughs are arranged in a lofty building. Each of these is inclined sufficiently to allow the water to run gently over its surface, to the lower end, where it passes to the trough beneath, whose inclination is in the opposite direction, and thus in succession till it reaches the bottom.

In either of these ways, the water is brought to a density of 1.14; about 9-10ths of its original quantity being evaporated. It is then conducted to large reservoirs, where it deposits the insoluble matters which were mixed with it.

Artificial heat is next employed. The brine, after having become clear, is introduced into boilers made of sheet-iron, and of great size. In some cases, the whole process is completed in one of these. But in the most perfect establishments, two are employed. In the first of these, the water is rapidly boiled and concentrated until the salt begins to crystalize; and during this operation, the greater part of the double sulphate of lime and soda is deposited. As the liquid wastes, more brine is added, which is also freed from this sulphate, and the boiling and addition of brine are continued until the vessel is filled with brine of the density of 1.23. In the next vessel the evaporation is conducted by a gentle heat, the liquid being barely kept at a boiling temperature, and as the salt forms at the surface, it is removed by rakes, until it manifests signs of the presence of the bitter sulphate and chloride. At or previous to this epoch, lime might be added, and the quantity of salt obtained would be increased.

The mother waters, which remain after

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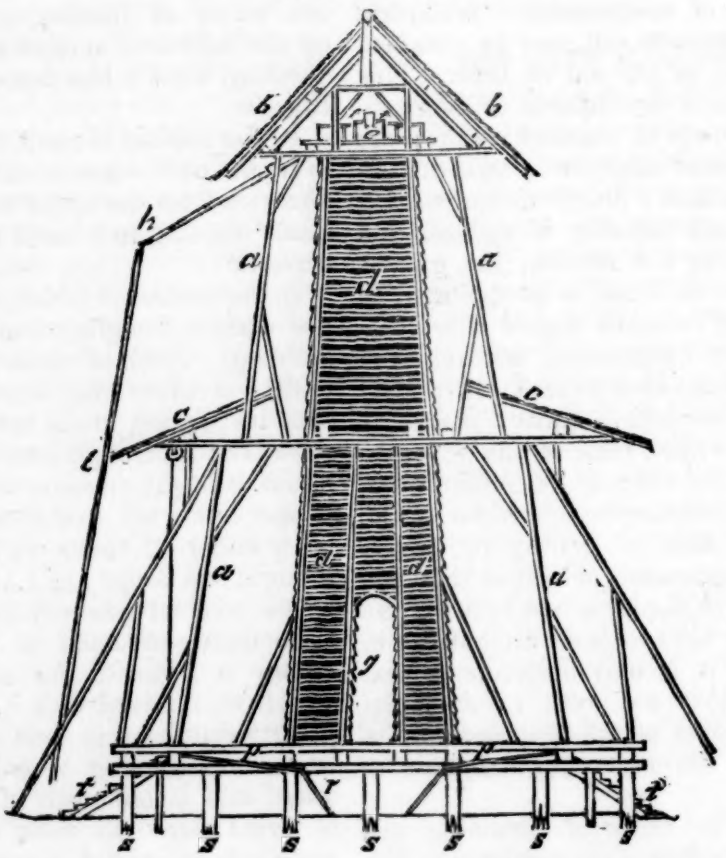
* 18° of Beaume. † 28° of Beaume.

the salt becomes impure, are set aside, and permitted to stand over a winter, exposed to the influence of frost. At a low temperature the sulphate of magnesia is decomposed by chloride of sodium, and sulphate of soda results. The several substances in the mother water form three successive deposits, of which sulphate of soda is the last, and the only one of any value.

A section of a building containing hurdles, for the purpose of concentrating water holding salt in solution, by spontaneous evaporation, with a part of the machinery, is represented in the annexed plate.

PLATE II.



a, *a*, *a*, frame.
b, *b*, upper roof.
c, *c*, lower roof.
d, *d*, *d*, piles of hurdles.
e, main channel for the brine.
f, *f*, lateral channels to distribute the brine upon the hurdles.
g, open space for the circulation of air.
h, *i*, jointed brake, by means of which the brine may be admitted from the main into either of the lateral channels at pleasure, or distributed in variable proportions in each, according to the direction of the wind. For this purpose, notches are cut on the side of the main channel, and to each side of it a plank is applied cut into similar and similarly situated notches. These planks are caused to slide along the side of the main channel, and, according to their position, may close the notches altogether, leave them partially or wholly open.
p, *p*, inclined planes to catch the brine as it falls from the ends of the hurdles.
r, reservoir.
s, *s*, *s*, piles which serve as foundation.
t, *t*, steps to ascend to the inclined planes.

At one of the European establishments, the spontaneous evaporation is carried farther during the summer months For this purpose, a building is constructed about 300 feet in length. A number of troughs extend along the upper part of this building, and from holes in their lower surfaces, a number of endless ropes proceed and pass around sleepers at the level of the ground. Beneath these is a reservoir for the brine.

Brine brought, in either of the modes we have mentioned, to the density of 1.14, and then concentrated by boiling to 1.23, is introduced, without being permitted to cool, into the troughs, and thence flows over the cords. It is then pumped back and per-

mitted to flow down a second time ; at each passage salt is deposited upon the cords, until the fluid assumes the viscid character of which we have spoken, when it is permitted to escape into the receptacle provided for the mother water. In this way, the crystalization of the salt, which occupies from seven to eight days in the method of slow boiling, may be completed in seventeen or eighteen hours, and the salt is of superior quality. There will form, also, in the reservoir beneath, large white crystals of salt. The cords are about a third of an inch in diameter, and when the thickness of the deposit upon them brings the joint diameter to about 2½ inches, the salt is removed by an instrument contrived for the purpose of breaking it off, and falling into the reservoir beneath, which must, of course, be then empty, may be collected.

When the first part of the process only is conducted by spontaneous evaporation, no more than 9-10ths of the fuel which would be required to boil away the whole of the water, need be used, and by the mode of crystalization upon ropes, even the half of this is saved, so that the saving is 19-20ths of the whole. Whenever, therefore, a cheap power for the purpose of raising the water, in order that it shall perform its several passages over the ropes, hurdles, or tables, can be obtained, the advantages of these methods are enormous. But it would even be a saving to use steam for raising the water ; for, the evaporation of a single cubic foot of water in the boiler of a steam engine will raise eighty cubic feet to the necessary height ; and the fire which raises the steam may be at the same time concentrating brine, if the boiler be filled with it instead of fresh water.

In the first attempts to make salt from the brine springs in the State of New-York, no other method than artifical evaporation was thought of. This was performed in the iron vessels made for the manufacture of potash. A better boiler was subsequently introduced, in which the smoke and heated air was made to circulate in tubes. The salt obtained in the earlier manufacture was much impaired in quality by the deliquescent chloride of magnesium, and was not free from the bitter taste given by it and the sulphate of magnesia. In this stage of the manufacture, Dr. McNiven was requested to propose a remedy, which he found in adding 1-1000th part of its weight of boiling water to the salt placed in bins, whose bottoms were inclined.— This quantity of boiling water being just sufficient to dissolve the impurities which a careful analysis showed to exist, and the solubility of common salt being but little increased by boiling, the separation was made at the least expense of that substance.

More recently, a method styled that of solar evaporation, has been introduced. In this the salt is placed in shallow pans beneath moveable roofs, by which the sun may be admitted and rain is excluded. It does not, however, appear probable that this method can be as rapid or as economic as those we have mentioned above. It must, in addition, occupy a vast extent of ground.

At the salt-lick on the Kenhaway, in Virginia, the brine is of great strength, 70 gallons of the water yielding a bushel of salt. This is 5 or 6 times as much as is usually furnished by the salt springs of Europe. Coal is also abundant in the immediate vicinity, and can be obtained at a low price. When these springs were first opened,* the waters drawn from a small depth was less rich, and the fuel used was wood. The evaporation was at first rapid, and performed in common potash kettles. To these succeeded shallow pans, first of sheet, and finally of cast iron, which are still employed.

The water drawn from the tubes, which are sunk 80 or 90 feet into the rock, is first exposed for a few days to the sun and air, by which the carbonic acid with which it is charged is dissipated, and the carbonates of lime and iron, held in solution by excess of that acid, are deposited. The clear liquor is then boiled to dryness, and the salt allowed to drain.— The salt thus obtained is of course in fine grains. Salt in large crystals is also made at the same place by heating the brine to a moderate temperature in large shallow pans, by means of tubes in which waste steam from other operations circulates.

ROCK SALT.

Rock salt is sometimes so pure that it may be used without any preparation except crushing. In order that it may be

* See Silliman's Journal for 1834.

transported as an article of merchandise, it is cut into masses of the figure of a barrel, which are then enclosed in staves and hoops. The lesser pieces are used in the neighborhood of the mines. Such is the quality of the salt from the mines of Wieliczska in Poland, and Cardona in Spain.

In other mines the rock-salt is mixed with earthy matter, whence it must be separated by lixiviation; and that of Cheshire in England contains liquid solutions of deliquescent salts, which make it necessary to dissolve and re-crystalize. For the solution of the rock-salt in Cheshire the waters of salt springs which issue from the same formation are employed, or the rock-salt is carried to Liverpool, where it is dissolved in sea-water. In either of these ways the evaporation, which is always by artificial heat, may be performed at the least possible expense of fuel. The process is conducted with great skill, as is evident from the great purity of the salt it produces, which is more free from other saline matter than any other which is an article of commerce. Of this salt there are two varieties: one in small grains, (blown salt,) and of great whiteness, the other in cubic crystals, (ground salt.) The latter, however, is less perfect in form, and the crystals of less size than are obtained by spontaneous evaporation, hence it is of less value for curing fish, or for packing meat in the dry way.

Blown or stoved salt is made in Liverpool by the rapid evaporation of the solution of the rock salt of Cheshire in the tide waters of the Mersey, in large shallow pans of sheet iron. The original boiling point of the solution is 236° Fahr. The salt, as it forms, is drawn out and put into large baskets of a conical figure. After these have been permitted to drain for a time, they are placed in a stove and dried.

The coarse or ground salt is prepared by heating the solution only to 170°, at which it is kept until the evaporation is completed.

A variety, in still larger crystals, is manufactured for the use of the fisheries by evaporating at the constant temperature of 100°.*

In all the three cases the process ceases when the solution becomes viscid; the remainder is rejected under the name of *bittern*.

II.

NITRE.

History.—The nitrates of potassa, lime, and magnesia, are found in the soil in various places, and are probably frequently formed spontaneously. It is only, however, in warm climates that they are generated in the open ground in sufficient quantities to make them profitable objects of extraction. In colder climates, these salts occasionally form, in quantities worth collecting, in caverns, in cellars, and in damp buildings of masonry. The nitric acid which unites with earthy and alkaline bases to form these three salts, is formed by the absorption of its two elements, (oxygen and nitrogen,) from the atmosphere. This being suspected in France, a successful attempt was made to form artificial nitre beds, and thus a supply of this essential munition of war was obtained, when all access to the countries whence nitre had been previously obtained was prevented by the British fleets.

Rationale.—The theory of the formation of nitric acid from its elements, as they exist in the atmosphere, is not fully understood. The union does unquestionably take place by the passage of electricity; and the rain which accompanies lightning often exhibits traces of the acid; but the quantity thus produced is not sufficient to explain the large quantities of the nitrates which are found in some situations. We can only, therefore, state the circumstances which experience has shown to be necessary in order to the production of these nitrates. These are—

1. The presence in the soil of powerful alkaline or earthy bases, such as lime, magnesia, and potassa.

2. A certain degree of moisture, such as that in friable vegetable mould, after a gentle rain.

3. An elevated temperature in the air, as at the freezing point, the nitrates are not produced, and the process is not active below 70° of Fahrenheit.

4. The access of solar light, which seems to be absolutely necessary, although if it be

* See Henry, on Salt.

so intense as to dry the soil, the action ceases altogether.

5. In temperate climates, animal matter disseminated through the soil must be present; and this is so essential, that, when artificial nitre beds were first formed, it was supposed that the nitric acid was altogether derived from the organic matter. But the quantity of the nitrates which are formed, is far greater than can be accounted for in this manner. It is therefore analagous to the case of ferments, where by the addition of a substance capable of entering into fermentation, that action may be induced in a great quantity of other fermentable matter, which might otherwise have remained unaltered.

Native Nitre Beds.—The salts contained in the nitric soils of Bengal, Ceylon and Egypt are, nitrate of potassa, (nitre,) nitrates of lime and magnesia, sulphates of lime and magnesia, and common salt. In Ceylon the soil is mixed with wood ashes, and lixiviated. The water in its passage dissolves not only the saline matter contained in the soil, but the potash of the wood ashes, and by it the earthy nitrates are decomposed and nitrate of potassa results. In Bengal the advantage of the use of alkaline matter does not seem to be understood, and the earthy nitrates are lost.

The leys obtained from the earth by passing water through it, until it flows off tasteless, are in these warm climates partly evaporated by exposure to the sun and air, and partly by boiling until the liquid is saturated. It is then poured into vessels where on its cooling the nitre crystalizes. The mother water contains the earthy nitrates, (if not decomposed,) with part of the sulphates and of the common salt. But the crystalized nitre is by no means pure, containing a portion of the last named salts, as well as organic matter, which are usually, taken together, as much as 25 per cent.

ARTIFICIAL NITRE BEDS.

AUTHORITY—DUMAS. Chimic appliquee aux Arts.

These have been formed in calcareous soils impregnated with animal matter, as beneath butchers' shambles, and in ancient burial grounds. But this method has gone out of use, with the necessities which gave it birth. The only operation necessary was to stir the earth frequently, so as to expose fresh surfaces to the air, and at the end of a few months, a sufficient quantity of nitrate of lime was formed to render the earth fit to lixiviate. To the liquor, containing the nitrate of lime, common potash was added, in sufficient quantity to insure the decomposition of this earthy salt. The nitrate of potassa thus formed, was obtained by concentrating the liquor by boiling, and crystalizing. It was in this manufacture, that the large quantities of potash exported from this country to the continent of Europe were principally used; and the consequent high price of this article had a most important influence upon the clearing of our forests, and bringing them into cultivation.

In Sweden, the nitrate of lime is procured, by placing in a small wooden hut, upon a floor of wood or well rammed clay, a mixture of common earth, marl, and ashes, to the depth of two or three feet. This is thoroughly moistened with the urine of cattle, and stirred up once a week.

At Longpont, in France, a nitre bed is formed in an ancient quarry in calcareous rock; in the bottom of this a bed of three or four feet in thickness is formed of alternate layers of earth and stable manure, and the washings of a stable are directed to it. At the end of two years the mass is moved into the light, and is frequently stirred for two years more, when it is fit for lixiviation.

In some places the earth is prepared for the purpose by fencing sheep upon it. Their manure is removed every four months, and replaced by a layer of fresh earth. At the end of a year the sheep are taken off, and the earth is stirred, at intervals of two months, for two years more, taking care to keep it moist with the drainings of stables.

In Prussia, calcareous earth charged with animal matter, is formed into walls, by which the operation is rendered more rapid.

Upon the whole, these methods cannot be recommended as profitable objects of industry, but only as means which may be resorted to in cases of absolute necessity.

PURIFICATION OF NITRE.

AUTHORITY—DUMAS. Chimic appliquee aux Arts.

Crude nitre, or saltpetre, as it is imported from the East, contains about 25 per cent.

of impurities. These are partly saline, and partly organic, the latter derived from the animal and vegetable matter which exists in the soil. In this state it is unfit for its most important uses in the arts, and therefore requires to be refined.

To refine the crude saltpetre, two successive solutions and crystalizations are usually performed. In the course of these, the organic matter is separated in consequence of its insolubility, and the greater part of the foreign salts are removed, by taking advantage of their relative degrees of solubility and manners of crystalization.

The first solution is performed by putting water into a copper boiler in the proportion of one-fifth of the weight of the saltpetre. To this the saltpetre is gradually added as the liquid is heated, and at the boiling temperature the whole of the nitre is dissolved. The insoluble matter rises to the top of this dense solution, and may be skimmed off. In order to facilitate the formation of the scum, a small quantity of glue, dissolved in water, is added to the solution; this will carry with it, to the surface, all the matter suspended in the liquid. Cold water is also thrown upon the surface of the liquid, from time to time, in order to check the ebullition and permit the formation of the scum. After the last skimming, when no more solid matter appears at the surface, the liquid is made to boil violently for a short time, after which the fire is permitted to expire gradually. The liquor ceasing to boil, the saline matters which are not soluble in the quantity of water which is present, sink to the bottom of the vessel, where they are left by the decantation of the solution, while still hot. The solution is received in copper basins, which are covered with wooden lids, in order to render the cooling more gradual; in these basins all that portion of the nitre, which is more soluble in boiling than in cold water, will finally crystalize in the form of the basin.

The *loaf* thus formed is permitted to drain, by placing it on wooden shelves pierced with holes. The mother waters which run off, are still rich in nitre, and are preserved, as well as the scum of which we have spoken.

As these *loaves* have been formed by crystalization in water holding other salts in solution, the nitre, although much improved in quality, is still far from pure. It is therefore dissolved a second time in one-third of its weight of boiling water. The solution is treated with glue and skimmed as in the former case, and permitted to crystalize in copper basins. The loaves thus formed, are set aside to drain upon an inclined plane of wood, in which gutters are formed of sheet lead. These gutters convey the drainings to a common receptacle. The place in which the inclined plane is formed, must be sheltered from the weather, but have a free access of air. Several months will elapse before the loaves are thoroughly dried.

The scum is washed with caution, in order to separate the nitre which may have adhered to it, and the washings, with the drainings of the loaves, are concentrated by boiling until the solution is saturated, when they are permitted to crystalize. The washings of the scum of the second boiling give, on their first crystalization, nitre of excellent quality; they are therefore heated by themselves. The drainings and washings of the first boiling are usually returned to the boiler during the first operation. If earthy nitrates be present they are converted into nitre, and their bases precipitated, by adding sub-carbonate of potassa, (common potash,) as long as effervescence continues, to the drainings of the loaves.

An improved process has recently been introduced, in which nitre may be refined by a single solution and crystalization. To the water in the boiler, twice its weight of crude nitre is added, while cold; this quantity is increased as the liquid heats, until it amounts to five times the weight of the water. After the boiling has commenced, it is checked from time to time by the addition of cold water, in order that the insoluble matters may fall to the bottom, whence they are scraped out. The liquid is treated with glue, as before, and finally, by the addition of cold water, the quantiy of that liquid is increased to one-third of the weight of the saltpetre. When this liquid, by repeated skimmings, has become perfectly clear, the fire is permitted to expire, until no more is left than will prevent the liquid from cooling below 190° Fahr.

After the interval of a night, this liquid is removed by means of copper ladles, taking care not to disturb the sediment, which with the turbid portion of the liquor is left

behind. The liquid is emptied from the ladles into a vessel of the form represented in plate 3.

Fig. 1, section of vessel for crystalizing nitre.

Fig. 2, plan of do.

PLATE III.

Fig. 1.

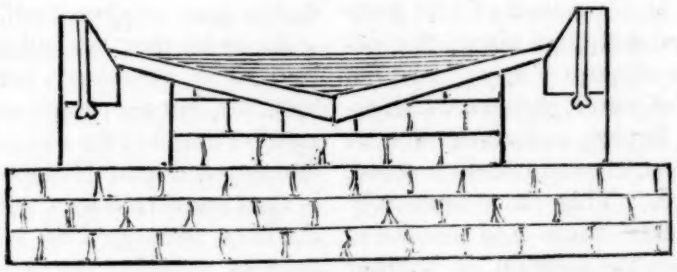
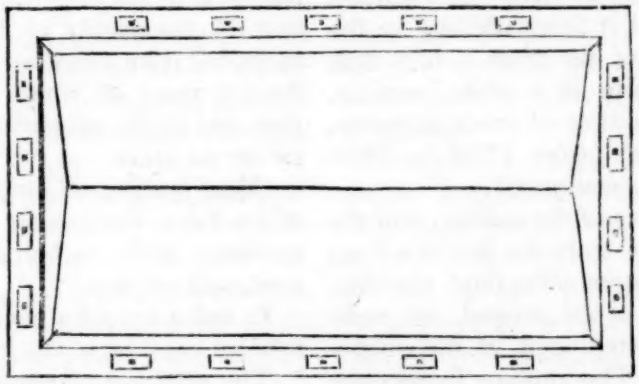


Fig. 2.



In these vessels the liquid is permitted to cool. As it cools, nitre is deposited in slender crystals, which are removed by rakes as they form, and heaped upon the inclined edges of the vessel, in which position the adhering liquid rapidly drains off. As soon as by draining, the nitre has lost its transparency, and become white, it is removed by means of copper shovels to a wooden bin. This has the figure of a truncated pyramid, with a false bottom, pierced with holes. Beneath the false bottom a hole is bored in one of the sides of the bin, to which a spiggot is adapted, as represented in plate 4.

Fig. 1, plan of a bin for purifying nitre by washing.

Fig. 2, transverse section of do.

Fig. 3, longitudinal section.

bb, false bottom pierced with holes.

s, spiggot.

In these bins the nitre is heaped up, until the middle of the heap is about six inches higher than the edges of the bin. It is then washed alternately with a saturated solution of pure nitre, and with pure water. After the liquor of each successive washing has remained for about three hours in contact with the nitre, the hole near the bottom of the bin is opened by withdrawing the

PLATE IV.

Fig. 1.

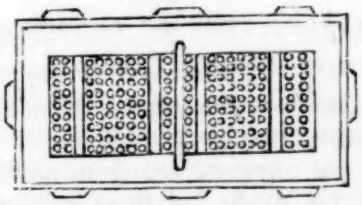


Fig. 2.

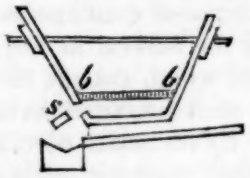
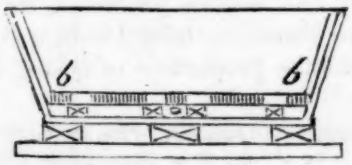


Fig. 3.



spiggot, and the liquor is allowed to drain off. The washing is completed when the

liquid, tested by the hydrometer, has the exact density of a saturated solution of pure nitre at the temperature of the experiment. In operating upon 3000 pounds avoirdupoise of crude saltpetre, 360 pints* of water are usually employed, in three successive washings. The first is composed of 150 pints of water, saturated with pure nitre; the second of 150 pints of pure water; and the third of 60 pints of water, saturatedwith nitre. The nitre having remained five or six days in the bins, is removed to a stove, in which it is dried. This stove is usually heated by the waste flame and smoke of the boiler, in which the solution of another parcel of nitre is going on. During the drying, the nitre must be frequently stirred, in order to prevent it from sticking to the sides and bottom of the stove. It is thus brought to the form of a white powder. Three thousand pounds of crude saltpetre, treated in this way, give 1750 to 1800 pounds of nitre of great purity.

The mother water of the boiling, and the liquid which drains from the first washing, are impure; the liquor of the third washing, and the latter part of the second, are sufficiently pure to be employed in the subsequent washings. The impure liquors are concentrated by boiling, treated with glue, and finally with carbonate of potassa, in order to decompose the earthy nitrates. Being then permitted to crystalize, and washed as before, they yield nitre of great purity.

MANUFACTURE OF GUNPOWDER.

AUTHORITY—DUMAS. Chimie appliquee aux Arts.

Rationale.—The nitrate of potassa, (nitre,) when rapidly heated is decomposed, giving out oxygen, nitrogen, nitrous acid, and nitric oxide, in their gaseous form. This decomposition is rendered more rapid by the presence of combustible bodies, and particularly of carbon in any of its more usual forms, which causes the gases to be evolved in such quantities as to produce detonation. By its action also, the oxygen is converted into carbonic oxide and carbonic acid. In order that the detonation may be certainly and readily produced, the carbon and nitre should be mixed with a substance which has the properties of taking fire at a low temperature, and of producing an elevated temperature by its combustion. Sulphur has these properties, and in addition, it appears that when it is heated in contact with carbon and nitre, a sulphuret of potassium is formed, which is even more inflammable than sulphur itself.

In order that the sulphur shall begin to burn, it is necessary that it be in contact with air, but the combustion may be kept up afterwards by the oxygen furnished by the decomposition of the nitre. As the sulphur is thus converted into sulphurous acid, and the heat generated is sufficient to render potassa volatile, the whole product of a mixture in proper proportions, may be gaseous, and this is the rationale of the common test of the quality of gunpowder, namely, to flash it from a shallow cup of brass placed upon a sheet of white paper, to which, if pure and in due proportion, it will communicate no stain.

Manufacture.—Gunpowder is made up of the three substances of which we have spoken: nitre, carbon in the form of charcoal, and sulphur.

In order to make good gunpowder, these articles must be of the best quality.

The nitre must be refined by either of the processes which have been described; of these the last yields it in the most convenient form.

Instead of the ordinary mode of purifying sulphur, a method invented by Michel, of Marseilles, is to be preferreed. In this,* crude sulphur is sublimed from a large iron kettle, which acts as a retort, capable of holding 15 or 1600 lbs. of sulphur, and which is charged with 1000 to 1250 lbs.—The upper part and neck of the retort are supplied by a dome and flue built of brick. The flue terminates in a brick chamber, which serves as a receiver. If flowers of sulphur are required, the chamber is large; but when masses in the form of cylinders (roll brimstone,) are needed, it is of smaller size. The first sulphur which passes over will burn in the oxygen of the air contained in the chamber. The chamber must therefore be furnished with valves, in order to let off the fumes, but which will prevent the entrance of atmospheric air. When the oxygen is exhausted, the sulphur will begin to form crystals (flowers of sulphur), on the

* Standard liquid measure of the State of New-York, which is to be always understood unless otherwise expressed.

* See DUMAS. Article Soufre.

walls and ceiling of the chamber, by which they will be heated until the vapor of the sulphur will condense in a liquid form on the floor. Hence it is withdrawn from time to time into proper moulds.

The charcoal must be made of soft wood, (willow, poplar, or alder,) and in some countries it is prepared for this purpose from the hemp plant. Soft wood is better than hard, inasmuch as the charcoal prepared from it is less charged with earthy and alkaline matter, and less liable to be inflamed by friction. The best mode of preparing the charcoal is by the distillation of the wood in iron cylinders, as we shall have occasion to describe under the proper head. The wood should not be of more than 5 or 6 years' growth, and should be stripped of its bark; for old wood contains more earthy and alkaline matter than young, and the bark more than the body of the tree. It ought to be cut when full of sap.

Long experience has brought the proportions of the three substances which enter into the composition of gunpowder, to that relation which the most accurate experiments, and the most severe consideration of the theory of their action, would have pointed out. Three principal descriptions of gunpowder are manufactured in the following proportions, although there is some variety among manufacturers in this respect.

Government Powder.

	For ordnance.	For mines	Powder for fowling pieces.
Nitre,	75	65	78
Sulphur,	12½	20	10
Charcoal,	12½	15	12

The first of these proportions insures the most rapid combustion of the gunpowder, and under favorable circumstances a complete decomposition of the nitre. The second burns with less heat, but produces more gas. In the first, if the combustion be complete, no excess of sulphur remains to act upon the metal of the fire arms, but as the powder may be damp, the third composition, although it produces less gas than either of the others, and less heat, is preferred in some cases; for, in consequence of the excess of oxygen produced by the nitre, there is less danger of the pieces becoming foul. The second composition, on the other hand, would speedily render small arms unfit for service.

In the preparation of gunpowder the charcoal and sulphur are first mixed together, by grinding them to powder. The nitre is then added, and the grinding continued until they are thoroughly incorporated in the form of a fine *meal*. The grinding was originally performed in wooden mortars, by means of wooden pestles; the latter are lifted by a water wheel, or other power, and fall by their own weight. They were originally of the form of a cylinder, but are now usually made of the shape of a pear. In some establishments the grinding is performed in cylinders, or drums, revolving around a horizontal axis. Within these are placed balls of an alloy of copper when the charcoal and sulphur are ground, and of tin when the three ingredients are to be incorporated.—In both methods the mixture is kept in a moist state, in order that it may be less inflammable.

Gunpowder in the form of meal burns slowly in consequence of there being but little air in contact with the sulphur, except at the surface of the mass. In order to give air access to the interior of a parcel, the gunpowder is formed into grains. The size of these grains varies according to the use, being largest for the charging of cannon, and smallest for small arms. In order to form meal gunpowder into grains, it is, while still moist, forced through seives, the meshes of which have a size adapted to that of the desired grains. The seives are made of leather, pierced with holes by a machine constructed for the purpose. The dust which forms is next sifted off, and returned to the moistened heap. For the military and naval service it only remains to dry the grains. This may be done, either by exposure to the sun and air, or in a chamber heated by a stove. The granulation was formerly wholly performed by hand, but of late machinery has been invented for the purpose.

For fowling pieces it is usual to *glaze* the gunpowder. This is done by placing dry granulated powder in a barrel, revolviug on a horizontal axis, and the polish of the surface is produced by the mutual friction of the grains.

Grains of a spherical figure are now manufactured. This form is preferred in service, and can be obtained at less expense, as the granulation is effected by a simpler machinery.

The machine for making round grains is

a drum or hollow cylinder, about a yard in diameter, and from 12 to 16 inches in thickness. This is affixed to a horizontal axle, around which a tube is adjusted that communicates with a reservoir of water. The tube being pierced with small holes, the head of water causes that liquid to issue from them in a shower of drops. Dry meal gunpowder is introduced into this drum, and during the revolution always tends to occupy its lower part. Upon this the drops fall, and roll; each of them thus becomes the nucleus of a spherical mass, whose size will depend upon the time that the revolution is kept up. The globules are sorted, by passing them through seives, and dried. By cutting off the supply of water, the same apparatus will glaze the grains.

3. BORAX.

Borax is a combination of boracic acid with soda, in which the alkaline matter is in such excess that it retains an alkaline reaction. This salt is found native in many parts of the globe, but is principally procured from a lake in Thibet. In its raw state it is mixed with an oleaginous matter, probably of vegetable origin, and with other salts of the same acid.

In order to purify it, it is reduced to powder, thrown upon a filtering cloth, and washed with a weak solution of soda, until the liquor passes off free from color. In this process, the soda forms a soap with the oleaginous matter, which is readily dissolved.

It is next dissolved in boiling water, in such quantity that the solution may have a density of 1.17.* Twelve parts of subcarbonate of soda for each 100 pts. of the borax are added to the solution, in order to decompose the other salts; and the liquor is filtered, in order to separate the precipitates. The liquor is again boiled, and then emptied into vessels of a conical or pyramidal form, in order that it may crystalize. These vessels are lined with sheet lead. In order to obtain the borax in separate terminated crystals, the rate of cooling in these vessels must be extremely slow.

Besides the lakes which furnish this subborate of soda, there are in Tuscany springs which yield boracic acid. These have recently been applied as sources of borax. At these springs, the boracic acid is now prepared by evaporation, in its crystaline form. In order to obtain borax, 600 lbs. of carbonate of soda are dissolved in 500 pints of boiling water, and 500 lbs. of crystalized boracic acid are gradually added to the solution. As the decomposition of the carbonate is attended with violent effervescence, the vessel must be at least twice as large as is necessary to contain the liquid. The solution being saturated by boiling, is crystalized as rapidly as possible, by cooling. The crystals are again dissolved in boiling water, to which 10 pts. of carbonate of soda are added, in order to decompose the earthy borates, arising from the impurities of the soda of commerce. It is then crystalized in the mode above described.

* 20° of Beaume.

4. ALUM.

History.—Alum is a double salt, composed of sulphuric acid, soda, and an alkali. It is a native product in the vicinity of volcanoes, whence it is sometimes extracted for use. It was first imported into Europe from Rocca (Edessa) in Syria, whence the name of Rock-alum frequently given to its crystals. A Genoese of the name of De Castro having noticed the mineral whence the Syrian alum is obtained, discovered the same substance in Italy, and introduced a similar manufacture at Tolfa. After the chemical nature of alum was discovered, it was found that a sulphate of alumina was often formed spontaneously, by the decomposition of iron pyrites in argillaceous rock, and that a similar decomposition might be produced, by roasting clay-slates rich in sulphuret of iron. These were therefore next employed in the manufacture of alum. Finally, since the great improvement in the manufacture of sulphuric acid, the acid and the earthy base have been combined directly.

MANUFACTURE OF ALUM FROM THE NATIVE ALUM OF TOLFA.

AUTHORITY.—DUMAS. Chimic appliquee aux Arts.

This mineral contains the proper proportions of the sulphates of alumina and potassa, united to a definite proportion of hydrate of alumina. The separation of the salts from the earthy matter cannot be effected until the water is separated from the hydrate. For this purpose the mineral is broken into fragments and calcined in a furnace, regulating the

heat in such manner that the sulphates shall not be decomposed. The calcination being finished, the roasted mineral is placed on a level earthen floor, in layers, each of which is sprinkled with water. The mass gradually assumes the form of a paste, and is ready to be lixiviated at the end of a couple of months. The lixiviation gives a (cold) saturated solution of alum, mixed with a turbid sediment. The liquor is evaporated by boiling in leaden vessels, until ready to crystalize, and is then permitted to cool. The crystals which are deposited first are octoedral; the next are cubo-octoedral; and the last cubic. The cubic form is now known to be owing to an excess of alumina.

MANUFACTURE OF ALUM FROM PYRITICAL SLATES AND SCHISTS.

AUTHORITY.—DUMAS. Chimie appliquee aux Arts.

The decomposition of iron pyrites spontaneously, or by the aid of heat, yields the sulphates of the protoxide and black oxide of iron. If, however, alumina be present, and the decomposition be complete, the whole of the sulphuric acid will combine with the earth and leave peroxide of iron free. This condition is fulfilled in argillaceous slates and schists containing pyrites. In some of them, the pyrites is subject to spontaneous decomposition; these only require to be exposed for about a year to the air. In other cases the decomposition may be effected by pouring water on the slate. When the pyrites does not decompose spontaneously, the mineral is roasted in heaps. In some cases schists are so rich in bitumen, that no more fuel need be applied, than is necessary to inflame the bitumen. In other cases, the heap is formed on a floor of wood, with layers of faggots between those of the mineral, or built into strata with coal.

The combustion of the heap being completed, the roasted mineral is lixiviated, or sometimes washed by directing a running stream against the heap.

Where wood is employed as the fuel, its ashes yield potasa, and when the wood is burned with coal, ammonia is produced. In either case, a portion of the sulphate of alumina will be converted into alum.

The liquor produced by lixiviation is concentrated by boiling, to a density of 1.333.* It is then permitted to rest for five or six hours, in order that the insoluble salts, and particularly those of the peroxide of iron, may settle. Being next placed in crystalizing vessels, the greater part of the alum which has been formed by the ashes of the fuel, is deposited in a crystaline form. The liquor is then repeatedly concentrated by boiling, and allowed to cool; at each successive stage of which, crystals of the sulphate of the protoxide of iron are left. Finally, the liquor becomes thick and viscid, from the presence of the deliquescent sulphate of alumina. This liquid, by the addition of sulphate of potassa, or sulphate of alumina, or of both, is converted into alum, which is precipitated in the form of powder. In order to give it the crystaline character, the powder must be dissolved in boiling water, and permitted to cool.

The persons who work aluminous slates and shales usually sell the sulphate of alumina to others, whose specific business is the manufacture of alum. In this case, the viscid liquor is evaporated to dryness, and the purchaser re-dissolves it. The dry sulphate of alumina has the consistence of grease or tallow.

MANUFACTURE OF ALUM BY THE DIRECT UNION OF ITS COMPONENTS.

AUTTHORITY.—DUMAS. Chimie appliquee aux Arts.

The clays (silicates of alumina) which are best fitted for this process, are such as are as free as possible from carbonate of lime and the oxides of iron. Such clay is roasted in a furnace, until it becomes capable of being readily pulverized. By this calcination, the principal part of the water is driven off, any iron which may be present oxidated to the highest degree, and the action of the sulphuric acid on the alumina facilitated.

The clay is next pulverized with care, and passed through bolting cloths, in order to exclude the coarser parts. This fine powder is then formed into a paste with dilute sulphuric acid; and as the two manufactures are usually combined, the liquid which comes from the leaden chambers* is used without concentration. Forty-five parts of this are mixed with 100 parts of clay. The mixture is placed in a stone basin covered by a vault, and heated by the smoke of the furnace in which another parcel of clay is undergoing the process of roasting, or by

* 36° of Beaume.

* See "Manufacture of Sulphuric Acid." SUPRA.

other waste heat. It remains in this basin several days, during which it is frequently stirred, and is then laid aside in a warm place, for more than a month. The mass is then repeatedly washed with water, which separates the sulphate of alumina which may have been formed. The liquor is concentrated to 1.17*, permitted to settle and decanted. The clear liquor is further concentrated to 1.21†, if the alum is to be formed by sulphate of ammonia, or to 1.38‡, if sulphate of potassa is to be employed. The subsequent concentration and crystalization are conducted as in the former cases.

The alum of commerce is rarely free from sulphate of iron. This renders it unfit for some of the arts, and particularly for dyeing silk. Alum in a sufficient state of purity for this purpose may be obtained by dissolving the alum of commerce in boiling water, in such quantity that the density of the solution may not exceed 1.26§. The solution, on cooling, deposits small crystals, which are free from the metallic sulphate. The mother water, on concentration and cyrstalization, yields common alum.

Alum is sometimes transformed into an acetate of alumina, which is better adapted to some purposes in the art of dyeing. This process may be conveniently included under this head.

PREPARATION OF ACETATE OF ALUMINA FROM ALUM.

AUTHORITY.—VITALIS. Cours de Teinture.

Three parts of purified alum, and one of acetate of lead, are dissolved in eight parts of boiling water. The solution being completed, 1-8th of a part of potash, and as much chalk, are added. The mixture is stirred at intervals, for a few hours. It is then permitted to rest, and when the precipitate has settled, the liquor is decanted. The solution still contains the alkaline sulphate which formed a part of the alum, but this does not impair its qualities. As the acetate of alumina does not crystalize, the solution is preserved in its liquid state for use.

5. SUPER-TARTRATE OF POTASSA—(CREAM OF TARTAR.)

AUTHORITY.—VITALIS. Cours de Teinture.

The *tartar* which collects on wine casks is this super-tartrate mixed with the coloring matter of the grape, and with tartrate of lime. In order to purify it, the crude tartar is reduced to powder, and dissolved in boiling water. The solution is decanted into vessels where the salt crystalizes on cooling, in a state almost colorless. To separate the residue of the coloring matter, it is again dissolved in boiling water, to which four or five per cent. of clay is added. The liquid is boiled until a thick pellicle of the salt has formed at its surface. During the boiling, the coloring matter will have combined with the alumina of the clay, and on crystalization, a colorless substance is obtained.

*20° of Beaume. †25° of Beaume. ‡40° of Beaume. §30° of Beaume.

The five salts whose preparation has been described above, are the most important of those with alkaline and earthy bases which are prepared on a large scale for use in the arts. In the sequel, we shall have occasion to treat of some of their most important applications. The preparation of the metallic salts can be more appropriately considered under the head of the metals.

From the American Railroad Journal.

BALTIMORE, 16th Nov. 1835.

D. K. MINOR, Esq.

Sir,—The subscriber, having invented an improved Rail-track, and also an improved Railroad Car-wheel, is desirous, through the medium of your columns, to make known the general outlines of his plans, and when his leisure will permit, a more detailed specification of them.

IMPROVED RAIL-TRACK.

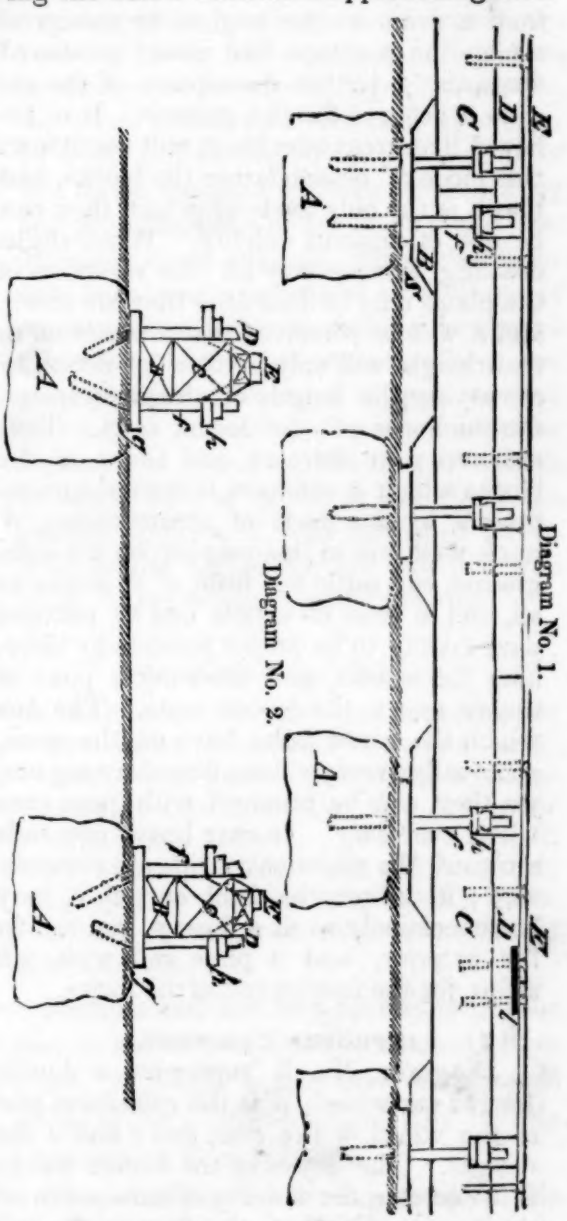
Various plans have been adopted in the United States for the construction of Rail-tracks, each of which has its respective advantages and disadvantages, and so obvious is it that the advantage which one possesses over the other, is gained by the sacrifice of some principle which it is desirable to maintain, that it is difficult, if not impossible, to decide which is in the whole superlatively good.

Some Engineers contend for the superiority of tracks made entirely of stone and iron, and rest their opinions on the important fact of using no perishable materials. Others believe that tracks made wholly of wood and iron are generally the best, on account of their lesser first cost, and wear of the machinery which plies upon them.

The objections to the former plans are, their unyielding nature, and their liability to short settles. To the latter, their want of stiffness, and the perishable nature of their component parts.

In the construction of Rail-tracks, it is desirable—First, That their bearings should be of uniform solidity; second, That the rails which rest upon them should have their joints perfectly broken, so that the weight of each car passing over them, may at all times be distributed on at least three supports; third, That the foundations should be of unperishable materials, and no part of them above the surface of the ground, so that they may be stable, and not interfere with the formation of a horse-path, where one is necessary; fourth, That there should be in them some spring, but not enough to make a perceptible increase of motive power necessary; fifth, That any wood which is used in their construction should be elevated above the surface of the ground, its durability being decreased one-half by coming in contact with it; sixth, That the verticle pressure of the cars should be nearly over the centres of the bearings and rails, so as to prevent a disposition to tilt; seventh, That the rails should be occasionally tied, so as to counteract the disposition to spread; eighth, That they should be so constructed as to offer the greatest possible facilities for adjustment. Many of the tracks which have been constructed possess some of these desiderata in great perfection; by one of the following description, it is believed they all may be obtained at a moderate expense.

Diagram No. 1 represents a longitudinal, and diagram No. 2, a transverse section of the rail-track. A, A, &c. are stone blocks bedded in sand or gravel, three feet apart from centre to centre lengthwise of the track, and every fifth one extending entirely across the track. Their tops coincide with the surface of the ground. After they have been brought to a bearing with a common maul, they are to be consolidated by raising a given weight a given height, and letting it fall a given number of times on each block; the degree of consolidation to depend on the texture of stone. B, B, &c., locust rests, 1 foot 9 inches long, by 6 inches wide, by 3 or 4 inches deep, the depth to regulate the level of the upper surface of the rails. C, C, &c., 6 by 6 inch southern yellow pine, strong pieces. D, D, &c., 2 by 3 inch seasoned white oak strips. E, E, &c., iron plate rails, spiked with 5 inch spikes to the timber below them. F, F, &c., inch screw bolts, bent at their lower ends and inserted in oblique holes drilled for their reception in the stone blocks, the holes nearest the centre of the track to be 6, and those farthest from it 4 inches deep. G, G, &c., iron plates 10 inches square, by ½ an inch deep, preventing the screw bolts from approaching each other at their bases, and affording a smooth bearing for the locust rests. H, H, &c., iron caps 2½ inches wide by ½ an inch thick, confining the oak strips in their right position on the string, preventing them from splitting, and preventing the screw bolts from separating at their tops.



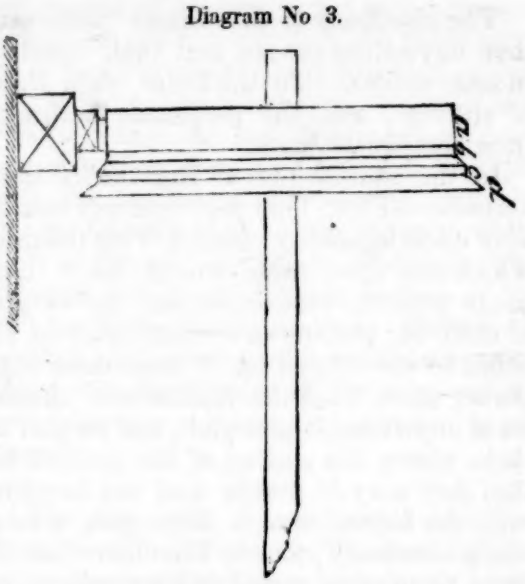
I, I, &c., plates on which the plate rails rest at their joinings, provided with a shoulder equal in height to the thickness of the iron rail, which confines them in their proper position at their joining, and hooks their joints.

It is proposed to consolidate the stone blocks with an engine fixed on a carriage, so arranged as to raise two weights at once, and provided with an *anchor* fixed in advance, to which a cord is to be attached, from a drum on the engine, by means of which the carriage can easily be moved forwards: a further description of the engine is deferred for the present. It is believed that great advantage will result from this mode of consolidating the blocks, and that it is the only mode by which they can be got of uniform solidity. What slight dressing is necessary for the reception of the plates may be done after they are down, and it will be perceived that a variation in their height will only involve the necessity of varying the length of the screws, and the thickness of the locust rests. That uniformity in the size, and shape of the blocks which is common, is rendered unimportant by this mode of construction. A track well laid in this manner, on dry solid ground, can settle but little, if it settles at all, and in case of settles can be restored with facility to its proper position by loosening the screws, and inserting a piece of timber under the locust rests. The *bite* which the screw bolts have on the stone, effectually prevents them from drawing out, yet they can be removed with great ease when necessary. In case heavy iron rails are used, the white oak strips are unnecessary; if the road be much curved, it may be economical to use a heavy iron rail for the exterior, and a plate rail with oak strips, for the interior rail of the curve.

IMPROVED CAR-WHEEL.

Diagram No. 3 represents a double *flanged* car-wheel; *a* is the *cylindrical* part of the wheel, *b* the *cone*, and *c* and *d* the flanges. The object of the double flange is to decrease the liability of cars to run off the track. Each of the flanges we will suppose of the usual depth. Now suppose an obstruction on the rail which would raise the wheel high enough to clear the first flange, that flange would fall on the top of the rail, and the wheel for a moment would roll on it, but with such an increased

Diagram No 3.



diameter as would restore it in half a revolution to its proper position. The effect of this is so obvious and simple, that a further description is deemed unnecessary.

Respectfully,

S. D. Steele.

Aerial Navigation by Birds.—A curious article on this subject appears in the December No. of the London Mechanics' Magazine. The writer is of the opinion that a sort of light wicker work may be drawn through the air by about 30 eagles. He thinks that young eagles might be trained in the same manner that poodle dogs and monkeys are in Naples—where he has seen them perform various amusing tricks.

We agree with him that to "realize a desideratum of this nature, it requires a person of property, who would devote his whole time (and money he might have said) to the pursuit; as the expense of purchasing and rearing up the eagles, together with able assistants, would be *considerable.*"

One method proposed for the guidance of this *team* is, by means of a long pole hung after the fashion of a rudder *before* the car; to the end of this, a piece of meat is to be fastened, and by varying the position of the pole the eagles are to be guided to one side or the other. Now setting aside this bird's aversion to any thing but *fresh* prey, we shudder when we think of the effect of a mental ejaculation of those eaglets equivalent to our "*sour grapes.*"

The writer himself thinks that "the subject in its childish state may appear to border on the ridiculous."

We do not mean to discourage any reasonable attempt to "navigate the air," but we do think it a fortunate circumstance that this gentleman is not a "man of property."

TRUE PATRIOTISM.—It appears from the Philadelphia National Gazette, that Bind Patterson, Esq., of Pottsville, Pa., has offered ONE THOUSAND DOLLARS A TON FOR TEN TONS OF GOOD IRON, SMELTED WITH ANTHRACITE COAL. This gentleman seems determined to go to work liberally, in bringing into play the resources of our country. It is the right way. We wish him success.

For the Mechanics' Magazine.

MACHINE FOR MAKING WROUGHT NAILS.

Our readers will recollect notice having been given, some time since, of a machine having been invented for the above purpose, by Mr. Simon Fairman, and therefore, to announce the same thing again requires an explanation. That explanation is as follows: Nearly two years ago, Mr. Fairman invented and constructed a machine for making wrought nails. This machine actually produced the effect of making wrought nails, and he sold the machine, together with the right of obtaining a patent. But it was an expensive and rather complicate machine, and we believe the purchaser thought it would cost more to keep it in order than would be gained by the profits, and therefore never attempted to put it in use.

But many of the most valuable improvements have been come at by approximation, and having pursued a wrong course, often enables an inventor to discover a better, until, by successive trials, he attains the desired effect. And so it proved with Mr. F. in this case. His first machine suggested to him another and a better plan, which he commenced putting in practice, but before he had completed it, his ever active mind suggested another plan, entirely different from, and infinitely more cheap and operative than either of the former. This he has now completed, and if there is any perfection in the arts, we should think a specimen of it was exhibited in this machine. Every part of the machine appears to be reduced to its lowest terms of simplicity, and with a degree of operativeness which cannot fail to do its duty—and is scarcely liable to disorder until its parts, which are constructed with great strength, shall be worn out in actual service.

We saw it in operation, making at the rate of about forty nails per minute, and to say they were handsome nails, would not be doing justice to the subject. They were in appearance such as an ingenious mechanic would make to exhibit as a specimen, by forging them carefully out of a piece of fine metal, and then finishing them by filing and polishing them in the finest shape that ingenuity could suggest. Mr. F. has hitherto been more successful in displays of useful ingenuity than in meeting the reward it merited; but if this invention does not place him out of the reach of want, we shall be ready to subscribe to the opinion, that ingenuity is a real misfortune. We think no small share of credit is also due to the patriotic gentlemen who furnished Mr. F. with means to perfect his machine, and bring his ingenuity to useful practice.

For the Mechanics' Magazine.

ON THE USES OF ZINC FOR ROOFING OF BUILDINGS, CULINARY VESSELS, ETC., AND ON THE PRODUCTS FORMED BY EXPOSURE OF THE METAL TO THE ACTION OF CORRODING AGENTS. BY L. D. GALE, M. D., PROF. GEOLOGY AND MINERALOGY IN THE N. Y. UNIVERSITY, AND PROF. CHEMISTRY IN THE N. Y. COLLEGE OF PHARMACY.

Metallic zinc has been applied to various uses in the Arts in Europe, since 1740 or 1750. Though it had been known and wrought for a long time previous by the Chinese and East Indians.

The abundance and cheapness of this metal, early attracted the attention of speculators to employ it in the useful arts, and it is stated in the Philosophical Transactions for 1747, that it casts and bores quite as well as brass, and it is proposed that it should be used for various culinary vessels

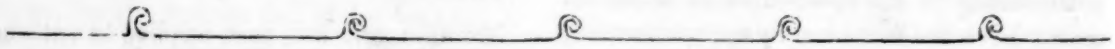
as a substitute for iron and other metals, that were then, and still continue in use for such purposes. The use of this metal for culinary vessels, attempted to be made, both in England and France, was of short duration, for it was soon ascertained that the various acids that are contained in a considerable proportion of our articles used as a vegetable diet, act upon the zinc, and that the compounds formed from the union of the metal with these acids, are both disgusting to the taste, and poisonous. Besides, it is found that the metal is rapidly acted upon, by contact with moist air, or alternate wetting and drying, and that when corroded, it is soluble in water, (as we shall state when speaking of the oxide of zinc,) forming a very deleterious solution, and rendering the water wholly unfit for ordinary domestic purposes.

Within a few years an attempt has been made to introduce the use of this metal for culinary vessels into the United States, and it was especially recommended as having the peculiar property of preserving the sweetness of milk for a much longer time than the materials generally used for such purposes, but unfortunately the anticipations were not verified in the trials, and the use of the metal for such purposes is now almost totally abandoned.

If milk be kept in a zinc vessel, it will, if exposed to a warm atmosphere, soon begin to undergo a change. An acid is formed, which attacks the metal vessel and dissolves a portion of it, forming a salt which is both disagreeable to the taste, and deleterious to the system. The metal cannot, therefore, ever be used for the above purpose with safety.

More recently, it has been proposed to use the metal for covering the roofs of buildings, as a substitute for slate, copper, and other materials, that have been for a long time in general use; and unfortunately for the public, large sums have already been expended for zinc roofs, which is worse than useless, when we take into consideration the trouble and expense of removing the material, and supplying its place with some other. One could hardly see how it is possible that the public should be so deceived in the use of an article that has been so thoroughly tried and condemned, both in France and England.

Nothing is perhaps more certain than the fact, that this metal can never be used advantageously for covering roofs. In the first place, the expansion of the metal is so great by slight changes of temperature, that the junctures are exceeding liable to get out of place from expansion and contraction, hence in the present manner of putting on the metal, the buildings are constantly liable to leak. In the second place, the metal is very brittle, so that two sheets cannot be put together by folding, but must be joined in a sort of double coil, thus:



And though this roof, when new, will shed rain tolerably well, it can never be made to resist the action of melting snow, as has been proved to the satisfaction, I trust, of a considerable number of our citizens, during the past winter. The reason of the leakage is quite evident to any one who has studied the principles of capillary attraction and the laws of fluids. Suppose, for example, that a roof covered with zinc contains a depth of six inches of snow, and that the snow melts rapidly and becomes saturated with water to the depth of three inches: this would have precisely the same effect in proving the roof as if its whole surface were actually covered with water to the same depth. The capillary attraction exerted by the water in the small spaces between the coils, together with the weight of a column of water three inches

in depth upon the same, is sufficient to allow water enough to pass through any roof thus covered to inundate the building.

It will be seen that the above objections apply equally to all metal roofs put together in the same manner. If we would keep our buildings dry, the snow must not be allowed to accumulate on them, or the metal used to cover the roofs must be made water tight by soldering. The past winter has tested, in the severest manner, roofing materials; heavy snows, followed by heavy rains and rapid thaws, have continually alternated during the whole season, and the damage done to buildings, furniture, and goods, will be felt for a long time.

The brittleness of zinc renders it highly objectionable. This property is increased in a tenfold proportion, by diminishing its temperature. At the freezing point of water it is almost as brittle as glass; and hence if any heavy body fall upon the coils which project above the roof, they are very liable to be broken, and when broken it is exceedingly difficult to repair them.

The third objection to the use of zinc for roofing is, that it is dissolved in the water which runs over the roof, and thus renders it unfit for all domestic purposes. This fact seems to be one that has not yet attracted the attention of the public. Having unfortunately resided under a zinc roof, and shared largely in its deleterious effects, I have been led to examine the qualities communicated to the water by means of the zinc.

There are two distinct compounds formed by exposing to the action of the air this metal. If the metal be heated to whiteness in the open air, it takes fire and burns with intense brilliancy, forming an exceedingly light, white substance, which is a compound of the metal with a portion of the oxygen of the air. It is therefore an oxide of zinc, and generally denominated the flowers of zinc. This is the only compound of zinc and oxygen described in most of the books; it is a white powder so light as readily to float in the atmosphere, and is perfectly insoluble in water.

If zinc be exposed to moist atmosphere, it becomes covered with a gray coating, which is described as a mixture of the white oxide and the metal; but as the gray compound is soluble in water, and neither of the others possess the same property, the opinion advanced in the books can hardly be correct. Berzelius, who first described the gray compound, considers it as a sub-oxide, though he does not mention the fact that it is soluble in water. This last property is one that renders the metal highly objectionable as a roofing, for the sub-oxide formed by the action of alternate wet and dry weather, is dissolved off by the rains, and carried into the cisterns, deteriorating the water, and rendering it almost entirely unfit for all domestic purposes. It thus acquires a styplic, coppery taste, and if taken into the stomach, produces nausea and vomiting. It decomposes soap, and produces that property in water called hardness, which renders it unfit for washing.

If the water which has dissolved the sub-oxide of zinc be freely exposed to the air, oxygen will be absorbed, and the sub-oxide will be gradually converted into the white oxide or flowers of zinc, which being insoluble in water, falls to the bottom as fast as formed in the state of a white powder, and thus the water at length becomes nearly pure again. This effect is quite perceptible after a dry season, when the water constantly becomes better, until it is again deteriorated by a fresh fall of rain, which dissolves more of the metal. Now, since rain water is so valuable an article in all large towns and cities, any agent that would deteriorate it must be got rid of, even if it be at a considerable expense. Besides, rain water, after being filtered through sand and charcoal, is now coming into use for drinking, and substituted for the spring water, which has been formerly universally

used for this and for all culinary purposes. It is, therefore, quite certain, that the use of zinc as a roofing for dwelling houses, at least, must be entirely abandoned, or otherwise, the use of rain water which runs from it must be partially or entirely discontinued.

From the Journal of the Franklin Institute.

REPORT ON THE USE OF THE HOT AIR BLAST IN IRON FURNACES AND FOUNDRIES. BY A. GUEYVEAU, ENGINEER AND PROFESSOR IN THE ROYAL SCHOOL OF MINES.

(Translated for this Journal, by Professor A. D. Bache.)

(Continued from page 111.)

The following details confirm the abstract of results just given.

1*st. Furnaces using coke or coal.*

The results as to economy by using the hot air blast are stated, in the Scottish works, as nearly 3 to 2. At Vienna, the same quantity of coke which was used for 1.075 of ore and flux in the charge, is now used for 1.51. At La Voulte, where the air is heated only to 320° in the manufacture of iron for forging, 1 part of coke is now used to 2.1 parts of ore and flux. At the furnace of Terre-Noire, 1 lb. of coke is used to 1.82 of the mixed ore and flux.

At Torteron, where a mixture of coke (1-3) and charcoal (2-3) is used as fuel, 1 lb. of the fuel is used to 2.83 lbs. of the mixed charge, with the hot air blast. While at the furnace of Guerche, where they use the same ore, flux and fuel, but with the cold air blast, 1 lb. of the fuel is used for 2.98 lbs. of the mixed ore and flux.

At Ancy-le-Franc, where charcoal is used, in the proportion of 2-3 oak charcoal and 1-3 of white wood, 2.1 lbs. of the ore and flux require 1 lb. of fuel with hot air, and 2.5 lbs. require the same fuel with heated air. At Wasseralfingen, the increase of the mineral charge, when hot air is used, is 1.43 to 1, and at Riouperoux, 1.42 to 1.

When iron for forging only is made, and fuel is scarce, it is thought that the hot air blast will be of but little advantage; the company who use the patent for this blast have stipulated for the Creusot furnace, not to pay for the construction of the heating apparatus, in case no real advantage is derived from its use.

In those furnaces which use the hot air blast, and where the mineral part of the charge has been increased, the charges pass less rapidly than formerly, and there are, of course, fewer charges in a given time, but so much more ore passes in the same time that the run of iron is much increased. This increase is greater when the iron is made of the quality for forging than when made for casting. At Vienna, where iron of the second mentioned quality is manufactured, the daily yield has increased in the ratio of 1.22 to 1, while at Janon, where that of the first named quality is used, the ratio is 1.6 to 1. At La Voulte, they produce in twenty-four hours 8 or 9 tons of iron for forging, and it is stated that with an increase of the blast, the yield could be increased to 11 or 12 tons without injuring the quality of the iron.

The greatest advantage from the hot air blast is undoubtedly to be found in the diminution in the enormous quantity of fuel (coal) used in some of the English works. The results obtained in the works of the south of France are the following. At Vienne, where they chiefly make iron for casting, they tried the Clyde form of heating apparatus, but abandoned it for that of Calder, by which they heat the air above the melting point of lead. The economy of coke has been in the ratio of 1.37 to 2.50. And the daily yield has increased from 4½ to 5 or 6 tons of iron. The daily product of the two furnaces at Janon, where Taylor's heating apparatus is used, is 8 or 9 tons of iron for forging, by the consumption per ton of 1.20 to 1.40 of coke. This does not include the fuel required to heat the iron. Each of the three furnaces of La Voulte turn out 9 tons of iron for forging, while, with the cold blast, they made but 7½ to 8 tons of the best quality, under the most favorable circumstances. The consumption of coke is now 1.25 to 1.30 tons for each ton of iron, besides about 600 lbs. per ton, which is required to heat the blast; the former consumption was 2.10 to 2.30 tons of fuel for one of iron. The experiments made in France with crude coal and the hot air blast, have not been conclusive in regard to its advantages, compared with the cold blast.

At the new Torteron furnace, where charcoal (2-3) and coke (1-3) are used, the consumption of fuel is about the same for the two kinds of blast. With the hot air blast,

however, they make excellent pig iron for castings without any difficulty.

2. *On the use of raw coal in smelting furnaces.*

The substitution of raw coal for coke is doubtless the source of the very great economy observed in the Scotch works, where the heated air blast has been introduced. It was generally believed in this country, as late as 1833, that the hot air blast was indispensable to the use of the fat varieties of coal, without cokeing. It was known that certain dry bituminous coals might be used as fuel, even without admixture with coke, and without heating the blast, as is still practised in Wales.

In some of the English furnaces, on account of the cakeing of the coal, or of its containing a considerable proportion of sulphur, coke is still used with the hot air blast. In one of the Welsh works, they partly coke the coal, and with good effect; a hint which may, perhaps, be improved upon here.

The following observations on the use of coal, of different qualities, with the common blast, have been collected.

A carbonate of iron was advantageously smelted at Vizille,* with a mixture of coke, and of very compact anthracite, with the cold air blast. The high price of the coke rendered the manufacture unprofitable. It has been found, at Creusot, that raw coal could be mixed with the coke used, in the proportion of fifty per cent. of the whole fuel, without injury to the quality of the iron, and without diminution in its quantity. At Decazeville, M. Coste found that all the neighboring coals could be used with the cold air blast, and the furnaces there, as well as at Firmy, have since used no other fuel, except when it was necessary to work up the fine coal. The same weight of raw coal is now used as was formerly of coke. The pig iron has not deteriorated in quality, and the daily yield is the same as before, namely, about five tons.† In all these cases, there is an advantage resulting from the less quantity of earthy matters in the charges, than when coke is used; it has been found at Decazeville, that they require but half the quantity of flux used with coke, when raw coal is substituted for it.

A fact of an opposite kind was presented at Alais, where an attempt to mix raw coal with coke was unsuccessful, the yield of the furnace being sensibly diminished when the coal was but one sixth of the charge. The coal appears, nevertheless, to be well adapted to this purpose.

At several of the furnaces, such as Terre Noire, &c., coke made from the fine coal is cheaper than the coarse coal, and no advantage can be realised by the use of raw coal.

In regard to the different kinds of coal, it has been observed that those which cake too much, or which fly to pieces, are both ill adapted to use in the smelting furnace. As to other varieties, they may be used either with or without admixture of coke.

The question as to whether the hot air blast is, or is not, necessary, seems to be undecided, observations being contradictory. It is possible that some kinds of coal may render the use of the hot air blast advantageous, or even absolutely require it, while others may work well with cold air. Some may require the hot air blast to drive off the bitumen before they reach the boshes, while others may not need such aid.*

3. *Smelting furnaces where charcoal is used as a fuel.*

These furnaces requiring a less draught, and being lower than those for coke, are peculiarly well adapted for placing the heating apparatus at the trunnel head. At Wasseralfingen, the pipes are nearly vertical, and pass from the lower part of the furnace to the platform, and back again to the tuyeres; at Ancy-le-Franc they are nearly horizontal, and directly above the trunnel head. An apparatus formed of curved pipes, passing in an arched form over the trunnel head, has been proposed by Mr. Taylor, but appears not to be as durable as that just referred to.

The experience of several years has proved that the heat of the combustible matters which take fire on issuing from the trunnel head, and of the other gaseous matters, will raise the temperature of the blast to 570° Fah. To this method of heating, several objections have been made; first,

* For an account of these important experiments, see this Journal, vol. xv., p. 346.

† In 1835, it is stated that the same furnaces run six tons per twenty-four hours.

* It is stated that, at Fredericksbutte, in Silesia, a successful attempt has been made to smelt with raw coal as a fuel, and with the cold air blast. The coal does not cake readily.—[Erdman's Chem. Journ.]

tnat in a well constructed furnace, the air issuing at the trunnel head should not be at as high a temperature as that required for the blast. This objection is not founded on observation, for, besides the heated gases which escape, and which do not burn, there are combustible ones escaping which take fire at the trunnel head, and give out heat by their combustion. It is a well known fact, that, in many works in France and Germany, the heat which would, otherwise, be lost, is applied to various useful purposes. A second objection is, that this mode of heating is dependent upon the proper working of the furnace, and may fail at the very time that heat is required to remove an obstruction in the furnace, from the effect of the very obstruction which is to be removed. This difficulty is easily obviated by burning a few faggots in the flues containing the air pipes, when extra heat is required.

In fact, this apparatus has proved generally satisfactory, requiring neither additional fuel, nor attendance. The exterior of the tubes should be cleaned about every fortnight, to remove dust, and other matters, which would impede the communication of heat. The cleansing of the long horizontal pipes, such as are used at Torteron, is an inconvenient matter.

It may be well to repeat, here, the results obtained by the hot air blast at Wasseralfingen. At a cost only of the construction and repairs of the heating apparatus, the daily yield of the furnace was increased thirty-nine per cent.; the quality of the iron, for casting, was not deteriorated; and the consumption of fuel was diminished from 1 to .61. The temperature of the air was from 390° to 400° Fah.

At Ancy-le-Franc, the consumption of charcoal per ton of iron was diminished twenty per cent., while the iron was improved for castings. The air was heated to 570°. The want of power of the blowing machine prevented a due supply of heated air, and the daily yield of the furnace was decreased.

I have been informed that there are several works in Franche-Comte, where they heat the air blast from the trunnel head. They have a greater daily yield, and consume less fuel than formerly, but state that the working of the furnace is not so regular as before. This, probably, depends upon some defect in their construction, since it certainly is not a usual accompaniment of the hot air blast.

At Hayange, (Moselle,) a furnace twenty-six feet in height, and using charcoal, was supplied with the hot air blast. By means of an apparatus like that used at Wasseralfingen, the air was raised to 612° Fahr., and even above this point. The area of the blast pipe was doubled, and the pressure slightly diminished. The charge of ore was increased from 430 lbs. for 22½ cubic feet of charcoal, to 680 lbs. The same number of charges were made per day, and the gain resulted only from the increase of ore in each charge. The heating apparatus has required no repairs since its establishment a year ago. In another furnace, at the same place, the heating apparatus having given way, the cold air blast was resumed at an additional expense of twelve per cent. of charcoal, per ton of iron.

It is stated in a German journal,* that by heating the air from a hydraulic blowing machine, by an apparatus at the trunnel head of a furnace, a saving of twenty-five per cent. of fuel had resulted. The air was heated to 480° Fah.

At Plons, in Switzerland, they have used the hot air blast to advantage, the fuel being a mixture of wood and charcoal. Each charge consists of 81 lbs. of charcoal, nearly half being from hard, and the rest from resinous wood, and 198 lbs. of pine wood, which would have yielded 48 lbs. of light charcoal; of 220 lbs. of ore containing 51 per cent. of iron, and 60 lbs. of an argillaceous flux. From 18 charges they obtain, in twelve hours, 20,196 lbs. of pig iron. The economy is reckoned at about 33 per cent.

These results are more satisfactory than those furnished by charcoal, alone, and cold air, or even than those afforded by charcoal and the hot air blast. So succcssful are they considered, that a saw mill has been established to cut the wood to the required size.

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* Erdman's Journal, vol. xviii., p. 340, 1833.

(To be continued.)

From the London Mechanics' Magazine.

Why cannot our artists attempt something of this kind?

EMBOSSING ON WOOD.

Sir,—I have been shown some very

beautiful specimens of embossing upon veneer, principally floral and arabesque designs, upon rosewood, maple, mahogany, elm, and other hard woods. The relief is almost *alto*, and has quite the appearance of carving. I understand the invention is patented, but that the inventor, M. Caccia, an Italian, has been prevented from bringing it into extensive operation from the primarily expensive nature of the machinery, and the jealousy of cabinet-makers, who declare that it would supersede carving and inlaying, and so spoil their business. The process may be so varied that the relief will be brought out in different colors; it is also applicable to the embossing of cloths, kerseymeres, waist-coat pieces, paper-hangings, and things of a like nature.

This is the first instance, as far as I know, in which designs have been impressed upon wood—embossing is common enough upon card, paper, calico, and such fabrics; and unless there be some improvement in the process, I do not know that the patent will hold good. Making the parts in relief come up of different colors, I believe to be new; and upon this possibly the patent rests.

Embossed hard fancy woods might be very extensively and very beautifully applied to the ornamenting of cabinets, workboxes, &c., and to the panels of doors and wainscoting. Herewith I send you some specimens, that in the effect produced, you may judge for yourself.

I am, &c.

P. B. T.

November, 1835.

From the London Mechanics' Magazine.

EVIDENCE OF DR. LARDNER

On the Great Western Railway Bill.

3d of August, 1835.

(Continued from page 94.)

[The witness is referred to two sections on the table.]

Were these prepared by you?—Yes. I was asked whether the summit level of the line had any necessary connexion with the power necessary to work it, and I drew these specimens to show that there might be two lines, one of which has a very high summit, and the other a very low one, and yet which require the same total power to work them.

Just produce them, and explain them?—If you suppose this section, No. 1, to represent two roads, one of them consisting of one continuous slope rising 1 in 300, and then one descending slope of 1 in 300, and then another, with the same termini, consisting of six short ascending slopes of 1 in 300 interrupted by six descending slopes of 1 in 300,—I take 1 in 300 as an example merely,—the power necessary to work these would be precisely the same.

According to the plan you now hold in your hand, though the lower line, the darker line, attains so much lower a summit level than the lighter line, the same power is required to surmount the one as the other?—Yes; the one is a succession of summits, and the other one only; and to compare these it would be necessary to bring all the ascending slopes to one end, and all the descending to the other, and on comparing you would then find them the same.

Does not it follow, then, as an inevitable conclusion, that the mere summit level of two sections does not of itself afford any thing like a conclusive estimate of the power necessary to surmount that summit level?—Certainly not.

A plan which shall show two summit levels, one twice as high as the others, may not give any thing like a fair estimate of the power required to surmount the two?—You must not judge by the summit level—very little depends upon that.

Is it not obvious that a much higher summit level may be obtained by less power than a lower summit level, if, in attaining the lower summit level, you have more objectionable inclinations?—Yes, every thing depends upon the graduation.

So that if power be lost on the lower more than the higher summit level, the mere surface would be calculated much to mislead?—It would not mislead scientific men or engineers.

But to mislead a common spectator?—Yes, people not acquainted with the subject.

In the section you have exhibited, No. 1, you say the same power would be required for the two lines?—Yes.

You have another marked 2?—Yes; in which the lower would require the greater power.

That is, the lower and darker section would require a higher power than the upper?—Yes; the slopes are more steep.

Yet they both start at the same point?—

Yes; and one is a higher summit level than the other.

And the sum of the ascents upon the undulating line on the last plan are greater than the sum of the ascents on the other?—That is not necessarily a test.

Is it not the case with this section?—It may be so; I have not measured it; that is not the test.

Explain how it is that less power is required to attain the higher summit?—If you add together all the perpendicular heights that the load has to be lifted in ascending, and then subduct from it all that falls upon an acclivity which is not more steep than 1 in 250, you will then get a number of perpendicular feet which the power is to overcome; but, in addition to that, it will be necessary to take those descending slopes which are more steep than 1 in 250, and allow for them as giving back so much power as they would give back if they were only 1 in 250, and then you get the number of perpendicular feet that the power is to overcome. The loss arising from steep slopes consists in this, that any descending plane more steep than 1 in 250, will only give back as much power as it would give back if it was 1 in 250; the consequence is, there is a number of perpendicular feet lost wherever there is a steeper incline than 1 in 250.

One in 250 is the point of rest?—That is the angle of repose.

Witness handed in the following paper:—

"*Calculation of the Amount of Mechanical Power necessary to draw a Ton from London to Bath, and from Bath to London, on the Great Western and Basing Lines, the Power being expressed in the equivalent Number of Pounds raised Three Feet high.*

"GREAT WESTERN RAILWAY.

"*London to Bath.*

	Feet.
Sum of all the rises	383
Sum of all the falls, not exceeding 1 in 250	243
	140
Fall at Box-hill, estimated at 1 in 250	51·98
To be overcome by power	88·02

	Yards.
Distance from London to Bath	192,588
Friction at 9lbs. per ton in pounds raised 1 y'd	1,733,292
Power to raise 1 ton 88·02 feet	65,722
Resistance from London to Bath in pds. raised 1 yard	1,799,014

"*Bath to London.*

	Feet.
Sum of all the rises	364·5
Sum of all the falls, not exceeding 1 in 250	337
	27·5
Effective fall of Euston-square incline	15·91
	11·59

	Yards.
Friction at 9 lbs. per ton in pounds raised 1 y'd	1,733,292
Power to raise 1 ton 11 59 feet	8,654
Total resistance from Bath to London in pounds raised 1 yard	1,741,946

"BASING LINE—*London to Bath.*

	Feet.
Sum of all the rises	480
Sum of all the falls, not exceeding 1 in 250	181
	299
Effective fall of slope 1 in 202	141·6
To be overcome by power	157·4

	Yards.
Distance from London to Bath in yards	187,396
Friction at 9lbs. per ton in pounds raised 1 y'd	1,686,564
Power to raise 1 ton 157·4 feet	117,525
Total resistance from London to Bath in pounds raised 1 yard	1,804,089

"*Bath to London.*

	Feet.
Sum of the rises	355
Sum of the falls	480
Total effective fall	125

	Yards.
Friction at 9 lbs. per ton in pounds raised 1 yard high	1,686,564
Effective aid derived from fall of 125 feet	93,333
Total resistance from London to Bath in pounds raised 1 yard	1,593,231

Mr. Talbot.—Is that taking all the slopes upon our line?—Yes; including Euston-square and the Box-plane.

Mr. Joy.—If it has been stated in evidence by Mr. Locke, that there are fewer accidents on the descending slope upon the Manchester and Liverpool Railway than upon other parts of the line, would not that answer—I do not mean intentionally—be fallacious in this respect, that the length of the line is about thirty-one miles, whereas the length of the incline is only about a mile and a half?—The fact that there are more accidents on that slope than on any other

portion of the line of equal length, is notorious.

You cannot fairly compare that plane with the whole line?—You cannot compare that one mile and a half with the twenty-eight miles.

Mr. Joy.—Have you some other tables marked 4, 5, 6, and 7, which you have prepared?—Yes; I wished to verify the result of the calculation, as it would be satisfactory to make them prove themselves, by making a calculation of the same thing, by two different processes and formularies, so that it should be seen, that it was not only arithmetically right, but right upon principle; and I have proceeded to obtain the total mechanical power necessary to work the lines by both methods; the results coincide so nearly as to perfectly verify each other.

[The witness delivered in the tables referred to.]

Are these tables illustrative of the speed?—These tables include the speed which the road would be traversed with, subject to two different conditions: one, that the maximum speed is limited to thirty miles, and the other to forty miles an hour: they also state the length of line in yards, and the mechanical power necessary to overcome every slope.

On each line?—Yes, expressed in pounds weight raised a yard high; they also express the resistance in pounds per ton every slope, from one end to the other.

Backwards and forwards?—Yes.

What are the termini?—Euston-square and Bath.

Not Bristol in either case?—No.

Mr. Joy.—Taking the speed in the first instance, as not exceeding thirty miles an hour for the maximum, what time would be consumed upon the Great Western from London to Bath?—From London to Bath on the Great Western would take, on that supposition of thirty miles an hour, four hours fifty-five minutes twenty-three seconds; on the Basing line, four hours fifty-nine minutes and fifty-seven seconds; and from Bath to London on the Great Western it would take four hours fifty-four minutes forty-four seconds, and on the Basing line four hours forty-three minutes forty seconds; and then both ways, backwards and forwards, on the Great Western it would take nine hours fifty minutes and seven seconds, and on the Basing, both ways, nine hours forty-three minutes and thirty-seven seconds; the difference in favor of the Basing line, six minutes and thirty seconds. This is on the supposition that the plane is 1 in 202.

Have you got the difference, if it was calculated at 1 in 250?—No, I have not.

With a speed not exceeding forty miles from London to Bath?—Four hours forty-four minutes and forty-four seconds on the Great Western, and on the Basing four hours forty-nine minutes and forty-seven seconds.

Bath to London?—Four hours forty minutes and twenty-one seconds.

Basing?—Four hours twenty-eight minutes and thirty-six seconds.

London to Bath and Bath to London, the Great Western?—Nine hours twenty-five minutes and five seconds; and on the Basing, nine hours eighteen minutes and twenty-three seconds; the difference in favor of the Basing, six minutes and forty-two seconds.

What rate do you assume on the level?—Twenty-five miles an hour.

Is that for the forty?—For both.

Have you got any other tables?—Yes.

Do they relate to another point of your examination?—A comparative view of the two lines with respect to their average power and their greatest resistance: the results are here brought together.

The results of the other tables are brought together?—Yes.

The witness delivers in the following papers:—

Comparative View of the Great Western and Basing Lines.

	G. Western.	Basing.
Total mechanical power necessary to work the line both ways, calculated by estimating the resistance upon each successive slope from the table of gradients, expressed in pounds weight, lifted three feet high	3,540,965	3,397,316
Difference of total mechanical power in favor of the Basing line	.....	143,649
Total mechanical power necessary to work the line both ways, calculated by allowing nine pounds per ton for friction throughout the whole distance, and then estimating the power necessary to lift the load through the sum of all the rises, and the quantity of this power restored by the sum of all the falls	3,540,960	3,397,320

Difference in favor of the Basing line	.....	143,640
Total length of the line in yards	192,538	187,496
Difference in favor of the Basing line	.....	5,192
Average resistance of the line, worked both ways, in pounds per ton	9·1879	9·0645
Difference in favor of the Basing line	.....	0·1234
Maximum resistance on ascending slopes from London to Bath in pounds per ton	35·05	17·96
Difference in favor of the Basing line	.....	17·09
Maximum resistance on ascending slopes from Bath to London in pounds per ton	29·93	20·09
Difference in favor of the Basing line	.....	9·84
Time of transit from London to Bath and from Bath to London, thirty miles an hour being taken as the greatest allowable speed	h. m. s. 9 50 7	h. m. s. 9 43 37
Difference in favor of the Basing line	.....	0 6 30
Time of transit from London to Bath and from Bath to London, forty miles an hour being taken as the greatest allowable speed	9 30 5	9 18 23
Difference in favor of the Basing line	.....	0 11 42
Length of an absolutely level line requiring the same quantity of mechanical power	Yards. 196,721	Yards. 188,739
Difference in favor of the Basing line	.....	7,982
Effect of the gradients expressed in equivalent increase of length	4,133	1,343
Difference in favor of the Basing graduation	.....	2,790
Comparative amount to which the power necessary to work the line both ways would be reduced if the Box-hill and Euston-square planes on the Great Western were converted into absolute levels, expressed in pounds raised one yard	3,466,586	3,397,318
Difference in favor of the Basing line	.....	69,268
Greatest resistance from London to Bath, exclusive of Euston-square slope, in pounds per ton	16·27	17·95
Greatest resistance from Bath to London, exclusive of the Box-hill slope, in pounds per ton	15·53	20·06

Since the preceding calculations were made, it has been proposed to reduce the gradient of 1 in 202 on the Basing line to 1 in 250. This will alter several parts of the comparative estimate of the two lines. In the following table I have made these changes:—

Comparative View of the Great Western and Basing Lines, the Gradient of 1 *in* 202 *being supposed to be changed to* 1 *in* 250.

	G. Western.	Basing.
Total mechanical power necessary to work the line both ways	3,540,965	3,373,128
Difference of total mechanical power in favor of the Basing line	.....	167,832
Total length of the line, in yards	192,588	187,396
Difference in favor of he Basing line	.....	5,192
Average resistance of the line, worked both ways, in pounds per ton	9·1879	9.0000
Difference in favor of the Basing line	.....	0·1879
Maximum resistance on ascending slopes from London to Bath, in pounds per ton	35·05	17·96
Difference in favor of the Basing line	.....	17 09
Maximum resistance on ascending slopes from Bath to London, in pounds per ton	29·93	17·96
Difference in favor of the Basing line	.....	11·97
Time of transit from London to Bath and from Bath to London, thirty miles an hour being taken as the greatest allowable speed	h. m. s. 9 50 7	h. m. s. 9 43 37
Difference in favor of the Basing line	.....	0 6 30
Time of transit from London to Bath and from Bath to London, forty miles an hour being taken as the greatest allowable speed	9 30 5	9 18 23
Difference in favor of the Basing line	.....	0 11 42
Length of an absolutely level line requiring the same quantity of mechanical power	Yards. 196,721	Yards. 187,396
Difference in favor of the Basing line	.....	9,325
Effect of the gradients expressed in equivalent increase of length	4,133	—
Difference in favor of the Basing graduation		4,133
Comparative amount to which the power necessary to work the lines both ways would be reduced if the Box-hill and Euston-square planes on the Great Western were converted into absolute levels, expressed in pounds raised 1 yard	3,466,586	3,373,128
Difference in favor of the Basing line	.....	93,458
Greatest resistance from London to Bath, exclusive of Euston-square slope, in pounds per ton	16·27	17·95
Greatest resistance from Bath to London, exclusive of the Box-hill slope, in ponnds per ton	15·53	17·95
Average resistance from London to Bath and from Bath to London, the Box-hill and Euston-square slopes being supposed to be reduced to levels, in pounds per ton	9	9

Have you calculated the length of a line absolutely level which would be mechanically equivalent to each of the proposed lines? —I have.

What is the difference in favor of the Basing line?—The length of a line absolutely level, requiring the same mechanical power as the Great Western Line, would be 196,721 yards; and the length of a line

absolutely level, equivalent mechanically to the Basing line, would be 188,739 yards. This is on the supposition that the greatest slope on the Basing line is 1 in 202, and in that case the difference would be 7,982 yards in favor of the Basing line.

Have you calculated what is the average power of traction per ton required upon each of the two lines?—Yes, I have. The average resistance of the line worked both ways expressed in pounds per ton for the Great Western is 9.1879, and for the Basing 9.0645; that is, in more popular language, it would be 9 lbs. and 19-100ths for the Great Western, and 9 lbs. 6-100ths for the Basing; that is supposing the slope to be 1 in 202, and taking into account the Euston-square slope, and the Box-hill slope, taking into account the whole line and every thing on it.

Will you have the goodness to tell me if you have made any calculation of what force must be applied to the break in order to prevent an increase of speed down the Box-hill slope?—The resistance that the break must exercise to oppose the descent of the load down the slope I stated to be 12 lbs. per ton; then, in order to produce that, the break must be pressed upon the tire of the wheel with such a force as to give that resistance, namely, 12 lbs. per ton. Now the pressure of the break upon the wheel would require to be from five to six times the amount of the resistance required, because the proportion that the actual pressure of the break bears to the resistance, supposing it to be made of such a wood as elm, will be five or six times, so that, if we want to produce a resistance of 12 lbs. a ton, we must press the break upon the wheel with a force amounting to 60 or 70 lbs. a ton.

This is assuming the friction necessary to retard going down the Box-hill?—Yes.

Now give me the same answer with reference to the descent at Euston-square?—That is 1 in 86, I believe. The force down a plane of 1 in 86 would be 17 lbs. per ton, and 5 times 17 are from 85 to 90 lbs.; that would be the pressure necessary to counteract the whole resistance.

What means have you taken to verify the calculations you have made respecting the mechanical power and other matter to be satisfied of their accuracy?—In my calculations I have proceeded by two totally different processes and formularies. In the one case I have considered the resistance that the power has to overcome from one end of the line to the other by the friction; this is 9 lbs. per ton; the total effect of that is a matter of easy calculation. I then consider separately the effect of all the rises and all the falls. In every rise the moving power must lift the whole weight of the train through the number of perpendicular feet in the rise; in every fall less steep than 1 in 250 a quantity of power is got back equal to the number of perpendicular feet in the rise; in every fall more steep than 1 in 250 the quantity of power is got back equal to the number of perpendicular feet which would be found if the fall was only 1 in 250. Having computed these, I then combine them with the result of friction; the latter is 9 lbs. per ton. I add them or subtract them, according as gravity assists or opposes the friction, and the result is the total mechanical power acquired to transfer the load from one end to the other, and I do this in both directions, and add the results, and get the total power both the one way and the other; that is one way of calculating. Then I made the same investigation by another totally distinct method; in this case I took all the slopes from one end of the line to the other. I take the common method of expressing the resistance to the drawing power on each slope expressed in pounds weight per ton; from that resistance and the length of the slope I obtain by a simple arithmetical process the total power required to draw a load from one end to the other of the slope. Having done this for all the slopes from one end to the other of the line, I added the results together, and obtained the total mechanical power in both directions. Now, upon comparing the results of those two methods of calculation, you can see how nearly they coincide.

Do you find them nearly coincide?—From Bath to London there is no difference in the calculations: they agree to the last unit. On the Great Western, and from London to Bath, there is a difference of 5 lbs. in rather less than 2,000,000 lbs.; and on the Basing line, from Bath to London, a difference of 1 lb.

Can you at all account for that slight difference?—Yes; it arises, most probably from a few decimal places being neglected in the one case that were taken in the other.

In the calculation you made, have you ro not included the slope of 1 in 86, the Euston-square slope, and 1 in 107 at Box-hill? —I have included the power absolutely expended in working the slopes, but I have not made any allowance for the waste of power which must be incurred in whatever way these slopes are worked. If it is worked by a single rope, I have not included the power necessary to pull the rope back, or to work the rope, but the bare power necessary to draw the load on the slope.

How does it happen that the Great Western line has the effect of an ascent in both directions?—That is a very common consequence of graduation. The line at the one end may be a number of perpendicular feet below the other end, and the graduation may be such that it may have the effect of an up-hill both ways, as is the case on the Great Western; that arises from the two steep inclines. In going down those steep inclines we do not get back the power that is expended in ascending, and they do not give it back for the reason I have already stated; they can only give it back at the rate of 1 in 250. Now the acclivities are both considerably greater than this, and consequently a number of perpendicular feet of fall are lost.

Mr. Talbot.—Allow me to call your attention to this question; you have stated that in the case of the tunnel there would be so much greater power required, and that power requiring a greater proportionate quantity of combustion, that the ill effects would be produced in that proportion?—Yes, on a given quantity of air.

You did not add that. To a question, what would be the proportion of increase in the consumption of fuel, you say, as thirty to nine. "In the same proportion as the increase of power?" "Yes; I may assume that the destruction of vital air and the production of noxious air is in the proportion to the mechanical power exerted?"—Yes.

And only that?—Only that.

Then the consumption of power up the Box tunnel is as thirty to nine?—Yes; there are 30 lbs. of power to 9 lbs. on a level.

What is it the other way?—What do you mean?

Descending?—Nothing at all; there is no power used in descending.

If there be no power at all that way, may I not say that, taking it both ways upon two trips in this tunnel, I have an average of fifteen to nine?—If you put it in that way.

Is that an unfair mode of viewing it?—That depends upon the object you have in view in putting it so. The fact is, you consume no fuel in going one way, and you consume it in the proportion of thirty to nine in the other.

And this tunnel being to be used both ways, it is not fair to consider the quantity of noxious air and the destruction of vital air both ways?—Yes, provided that is the way you state it.

I want to know whether you accede to that?—I stated all the conditions, and my statement alluded to the passage of an engine up the tunnel from one end to the other. The passengers who descend being free from annoyance, is no relief to the passengers ascending.

That sounds very clear and very amusing to my learned friend; but when we are upon the consumption of vital air, practically speaking, and trains working both ways, and passengers going both ways, am I not entitled to consider there is no consumption of vital air one way?—Yes.

Is it ridiculous to suppose that?—No.

Is it not an absolute fact?—Yes, it is.

Then it ought to be as fifteen to nine?—No, certainly not; not so far as regards any effect produced upon passengers.

You mean, when any effect is produced, it is as thirty to nine?—If there happened to be two trains passing at the same time in opposite directions, all the passengers coming down would receive the ill effects as the passengers going up, without any one receiving any benefit from the descent.

Do you mean to state, that with trains going both ways the consumption of vital air in the tunnel is in the proportion of thirty to nine, compared to a level?—No, not with the same number of trains, but I have alluded to a single train during its passage.

And during the ascent?—During the ascent.

Then with respect to those two trains going in different directions at the same time, the consumption of air would in this tunnel, wtth respect to another tunnel with the same length on a level, be as eighteen to thirty?—Yes.

In favor of the level tunnel?—Yes;

but that is a thing never likely to happen.

Are you not, in your calculations of the effect of the noxious air given out, assuming that for a moment there is no draught?—Yes, I am decidedly of that opinion. I do not think that the shafts in the tunnel would be found to produce any good effect for the passing engine, though they will probably ventilate it for the next train; but the passage through will be so quick that no effective ventilation will have time to take place for the passing engine.

Should you like a tunnel a mile long without shafts?—I think that the shafts will not be found to be the best means, and my opinion is, that they must ventilate long tunnels by other means.

Have you any practical experience upon that subject?—No, and no one has any practical experience in tunnels of this great length upon slopes.

Are you sure of that?—I do not know of any; I never saw or heard of them.

A tunnel of a mile long?—Worked by locomotive on a slope; I am not aware of any.

What is the longest tunnel you have known?—I know of no tunnel a mile long worked by locomotives.

Mr. Talbot.—Should you like a tunnel of a mile long without shafts as well as one with shafts?—I have no experience upon the subject.

You are a scientific gentleman of great eminence put into the box to favor us with your opinion; I want your opinion?—My opinion I have stated already, that I apprehend shafts will not produce a material relief for the passing train; they may, and probably will, ventilate for the next train. In the transition of the train through a certain length of the tunnel, there is not time for the ventilation to take effect. If the atmosphere in the tunnel be, as it generally will be, still, then the engine, as it draws the train through, will produce a quantity of noxious and annoying air; that air will remain immediately behind it, and the train will instantly be involved in it, and one cannot suppose that there will be time for that air to go up the chimney or shaft between the passage of the engine and the passage of the train of passengers; and my idea is, that they will be obliged to resort to artificial means to carry off the foul air.

Mr. Talbot.—Why should not the train of carriages leave it behind?—So it will, and it involves the train; it is because they do leave it behind that it involves the passengers.

Suppose it rises to the roof in a tunnel thirty feet high, how much will it be above the train of passengers?—I cannot recollect the height of the carriages, twelve or fourteen feet.

The chimney is fifteen?—The carriages are very high; they go up a considerable height of the chimney.

There would be from fifteen to twenty feet between them and the roof of the tunnel?—Yes.

Do you think that this air is to rebound almost perpendicularly upon the train of carriages?—I have no doubt of it, from the velocity with which it comes from the chimney. I may state that there is a jet of high-pressure steam turned upwards in the chimney; it is blown out of the engine, and it is presented perpendicularly upwards in the chimney. All the high-pressure steam that works the engine is blown with prodigious violence up the chimney; this carries with it the noxious air, and they are driven against the roof of the tunnel with this force; they do not go up with their natural force of draught, but they are carried up and strike the roof with force of the steam, which is so considerable that they would come down upon the first carriage like a ball rebounding.

I want to ask you to explain one thing, which to me requires explanation. You told their lordships that the acclivity of the slope had nothing to do with the strength of an endless rope, because it balanced itself?—Yes.

I should be glad to know how you explain that?—If you put an endless rope over a pulley actually perpendicular, which is the extreme case and the greatest acclivity, and apply the power to it to put it in motion round the pulley, you will require a certain force to do it; and if you put the same rope upon a level it will require the same force, because the rope balances itself.

If there was a pulley at the top of this room, and I put a thread over it in the one case, and a nine-inch rope in the other?—I am speaking of the same rope.

You stated that the acclivity had nothing to do with the strength, from which I infer that the same rope will do; am I wrong?

—No, provided it is to draw the same load —not the same load because the acclivity makes a difference in the load, but I am speaking of the rope itself—so far as the rope itself goes it balances itself.

You mean with the same strain?—Yes.

(To be continued.)

From the London Mechanics' Magazine.

SELECT COMMITTEE OF THE HOUSE OF COMMONS ON ARTS AND MANUFACTURES.

(Continued from page 31.)

MINUTES OF EVIDENCE.

Thomas James, Esq., examined:

The fabrics that I am best acquainted with in our house are silk manufactures; with respect to color, ever since the introduction of French goods, I think we have had a very considerable improvement in the colors, and in the patterns of the English silk manufacture, particularly in the colors—not only in the plainer, which may be called prismatic colors, but in those colors which are creations of fancy, the shades have been much more brilliant than we used to have them. The importation of French silks has almost entirely ceased in consequence of this improvement. The power of producing finer colors on the part of our manufacturers has increased,—as also there has been an increased degree of good taste in appreciating the colors. This improvement has been perceptible since the more free intercourse with France. Referring to Manchester and Macclesfield, the time the country manufacturers came to London, to attend the periodical sales of silk at the East India House, it was their custom to come to our house and other houses of our class, and obtain from us patterns of the shades of different French goods that we had bought or imported, and the imitation of these goods and patterns has led to these improvements, or at least has been co-existent with it. From the excellence and beauty of our fabric, if silk was still to advance and become dearer, the public would always repay that by an increased consumption. The difficulty of selling a bad shade of color, whenever it does occur, is increased considerably on account of the general appreciation of good colors. Until the last two or three years, the production and consumption of figured British silks was a mere trifle, but within the last year the production and consumption of British figured silks has been very considerable. The figures are smaller, and I think more beautiful in form than formerly. Combining the beauty of design with a certain degree of neatness as well in tint as in color, the silk manufactured in England has materially improved. Formerly they were most apprehensive of the figured silks from France, and the contest in them was thought hopeless, but there is now executing in Spitalfields a considerable order for figured silks for America, where, of course, they must meet the French under no circumstances of protecting duty. If, then, the beauty of English manufactured silk goods is so materially improved, from our manufacturers having the opportunity of seeing the French, there is a still greater capability of improvement, if more means of improvement were placed within their reach. I thi k a matter of the first importance would be to give to the parties who originate patterns a property in the patterns for such a length of time as would repay the outlay and encourage the productic n of patterns. The Committee is aware that such a protection is given to the printer. When a pattern is framed on printed cotton, the party is protected by the law in the exclusive right of the pattern for three months, and I would suggest that protection should also be given to patterns framed in the loom. It will be in the recollection of the Committee, that some years ago an India handkerchief was almost the distinguishing mark of a gentleman; every gentleman had one in his pocket. India-printed handkercheifs of very common patterns were sold at from 7*s.* to 10*s.* a-piece; now the great consumption of India handkerchiefs is by the importation of the unprinted cloth, and they are printed in this country with English patterns, but the cloths printed in India are now principally sold by hawkers to the lower class of consumers. In our figured patterns we borrow very largely from the French. It is very desirable that we should create an original taste here; we are still behind the French in ribbons and shawls; we borrow our figured patterns from France, in a principal degree. From the decided advantage that we have from China silk, and our application of China silk, I do

not fear that we shall decidedly beat the French in figured as in plain goods. I have heard that the French government sent a mission some few years ago into the region of Cachmere, both to introduce Cachmere goods, and also to speculate on the production of Cachmere shawls.

Mr. Thomas Field Gibson, examined:

I am a silk-manufacturer in Spitalfields. The description of figured silks which we are now making in Spitalfields are of a very small and insignificant kind; they are not of the large class of patterns. That is, the general class of patterns that are now making. They are almost entirely copies or variations from French patterns; there is but a very small degree of talent employed in Spitalfields in the production of patterns. We are almost destitute of original taste in that particular department. The French patterns are generally given to the pattern-makers by the manufacturers, and they either copy precisely, or make variations, as the manufacturer's or their own taste may suggest. I am not acquainted with any drawer of patterns who is an educated artist. A good pattern-drawer may obtain from 100*l.* to 200*l.* a year; but the remuneration varies with the description of pattern. It is also mixed up with a remuneration given for reducing the design to the mould, or cutting the card, which is necessary for the weaving it in the looms. I think that the two difficulties under which we labor at present, are, first, that we have no protection for patterns, so that if I make an outlay of from 20*l.* to 100*l.* upon a pattern, it may be pirated to-morrow by my neighbor, and I should have no compensation for it; and the second difficulty is, that we have no national taste in this department of art, that we have no originality in design in drawing of patterns, that we are compelled to make copies from French patterns in order to supply the demands of our customers. I think a school of arts open to persons connected with the manufacture of the country would be of high value and importance, coupled with the protection of patterns; but without a protection of patterns, no shool of design would be of any advantage to us. It is not to be expected that the master-manufacturers would undertake any part of the expense of such an establishment. The utmost that could be expected from them would be to give their time and attention to the arrangement and working of the system; and I believe the fact is, that in France the government, or the municipal authorities, or both together, do pay for the whole cost of the establishment. If the general taste of the nation was improved, it would be beneficial to our manufactures; and I would add, that ours is a manufacture which is capable of such extreme variety in shades of color, in the blending of shades, and in producing various forms of pattern, that there is hardly any one to which the exhibition of all works of art in which colors are concerned would be more beneficial. A protection for patterns should be for not less than twelve months. I can give a reason why a season or six months would not be a sufficient time. I was manufacturing a pattern in silk during the spring, to the order of a large house of business in London. I received orders from them to continue the manufacture of the same pattern in autumn colors; but in the last month this pattern was taken to Manchester and manufactured there. The order which I had received for the winter article was immediately countermanded, because it was produced at Manchester at a much less price. A heavy fine should be inflicted for piracy. Sometimes there are more than 100 pieces of the same pattern. It more often happens that there are less than 100; more often than not. According to the average return from the Chamber of Commerce at *Lyons*, the number of pieces made of fancy goods of particular patterns does not exceed 20 from the frame; what is the average production of England of the same manufacture, I have no precise knowledge of—but I should say double, at least 40. In French silks, in some cases, a very large profit is paid to manufacturers on condition that they shall produce a small number, and then destroy the design. A pattern should be protected by registering the actual pattern. With regard to printed goods, the custom is for the parties to print on the end, "engaged for three months," and after that period it may be copied by any body; that would be a suffieient protection if it was extended, as I said before, to twelve months—whatever registration took place should be a public and authentic one. The registration and location of patterns, representing the state of protection

in the particular trade, would be in itself a great means of advancing and improving the manufacture. There are no superior weavers solely employed in weaving patterns, and there is a good reason why this is so; a weaver could not himself produce the pattern to the manufacturer in the same way as he does at Lyons, because in London he is not possessed of machinery by which he could do it; the machinery belongs to the master manufacturer here, but in Lyons it belongs to the weaver. I have heard that in France, after the design has been produced, the weaver introduces a considerable modification into the pattern itself.

Mr. John Howell, (of the firm of Howell and James, Regent-street,) examined:

The manner of choosing our patterns or goods is as follows: it is usual for the Lyons manufacturers to come twice a year to England, that is, in the spring for the autum, and the autumn for the spring, and they produce perhaps 200 or 300 patterns, not paper patterns, but silk patterns or gauze patterns, or whatever it may be, and from these patterns we make our selection; and it sometimes happens that we have so good an opinion of certain patterns, that we say, "Now you must withdraw that, it must be made for us only," and for 20 or 30 pieces they will do that. Now, the English manufacturers never give us that advantage, they think it very expensive to put to work a pattern to show us the effect of it, for it looks so different on paper to what it is in reality, that we cannot decide whether we shall have it or not, and we often urge them to bring us a little piece ready, to see the effect of it; sometimes we want color, sometimes we want a little change in the disposition; but there has always been an objection to the expense incurred, and therefore we are obliged to bear the expense if we are content to order from a paper pattern; we have sometimes found it necessary to ask for a pattern-drawer or designer; not a pattern-drawer, because they are distinct businesses. I never found a good designer in England; a pattern-drawer is a different thing altogether; he is the man who puts the thing comparatively to work, as an architect designs the building of a house. Neither have I found a good pattern-drawer; the designer gives us a small pattern, and the pattern-drawer is the person who prepares the work; as an architect gives a drawing to the builder, so does the designer to the pattern-drawer. I think there are not so many persons that are capable of doing it in this country as in France; the pattern-drawer is the medium between the designer and the weaver. After the peace with France, I found the manufactures of France were superior to those of England; I mean in regard to silks of all descriptions; but I think a great deal of that arose out of having made use of better material; the natural silk of France has been considered better than any other country, but now we have an importation of that natural silk, and it is manufactured here. The importation of raw silk from France, by reason of its superior quality, has beneficially acted upon the English manufacture; I found their silks better the moment I had an opportunity to go and see them; but I have found them declining every day since; every time I go to France, I find the French silks are not so good as they used to be, in point of material and workmanship; they appear to be desirous of a large trade rather than a small good trade; the English manufacture has improved in a greater ratio, perhaps, since then. France is superior to us in design, but it is confined to very few houses; there is only one house at Lyons we can deal with largely, because their taste is always superior. I am speaking of design. We keep all our patterns; patterns fifty years old are very useful to us at this present moment. The French pay great attention to pattern shawls; they will give three or four hundred pounds for a Cachmere shawl, or India shawl, for the sake of the pattern. The shawls that were exhibited at the Exposition in France, were superior to the India shawls; the patterns are superior in the manufacture, as well as the combination of colors and design. It is all superior. I believe they have a superiority of machinery in the manufacture and execution as well. Will the Committee allow me to exhibit some pieces of paper, to elucidate the connexion between silk and other materials, the manufactures of the country? It shows how the introduction of good patterns will give a taste or style to other materials; it is intended for rooms in lieu of silks; and instead of costing two guineas and a half, a yard would only cost 2*s.* 6*d.* The inventors are De la Rue and Company, Bunhill-

row.—[*Mr. Howell then produced to the Committee patterns of various colors.*]

Mr. Robert Harrison, examined:

In designs and patterns in the silk trade we are very inferior to the French; and that is the principal difficulty under which we labor at the present time. We have not been able to find persons in this country who are capable of giving proper designs; the principal difficulty arises from the circumstance of men not having been brought up in this country to design for silk; it is very different to designing for printers, from the circumstance that it is necessary a man should be conversant with the principle of weaving, before he can make a proper design for silk. If we could only get designs in this country, we should be able to find parties that could put them on ruled paper for weaving. There is nothing but what we could make, provided we had a proper designer for the purpose of drawing patterns for weaving; and I think the principal difficulty arises from the circumstance of not having any school of art in this country, where young men would be enabled to pursue their studies for the purpose of perfecting themselves in drawing for that particular branch of the manufacture. There is no want of talent in the country, because there are a great many persons engaged exclusively in the production of designs for printed cottons, challis, and bandannas; we have in the trade individuals who can draw patterns, but are not conversant with the principles of weaving, and therefore we have been unable to put those patterns to work. We have now many patterns by us which are perfectly useless, because the drawing is not adapted to weaving. We would willingly, at the present time, engage a man at a handsome salary, conversant with the principle of weaving, as a designer, and also able to put the patterns upon paper. Foreigners are not superior to us in their colors; there is a brightness in their colors we certainly do not possess, but I think our colors are more permanent. The dying of colors has certainly improved within the last few years, and in many cases, the permanency of colors decidedly is more so than the French. It is necessary to have a perfect chemical knowledge before a man can be a good dyer. I understand the peculiar brilliancy of the French colors arises from the climate more than any thing else, and the water has something to do with it as well. It has occurred to me, if we had a school of arts established in this country, that a great many young men would be willing to make themselves conversant with the principle of weaving, for the purpose of procuring that particular study, and ultimately to become designers and drawers upon ruled paper for the silk trade. It would be a lucrative profession.

Mr. George Eld, Mayor of Coventry, examined:

In consequence of the public attention having been directed to the subject, I made some inquiry with a view to ascertain the number of persons engaged in the ribbon trade, and who had any knowledge of the art of desiging in Foleshill; with a population of 7,000, I could not find more than six persons in the whole parish who were capable of copying a pattern, and not one capable of making an original design. At Coventry there is a drawing class connected with the Mechanics' Institution of that town, but it is as yet quite in its infancy. The inhabitants of Foleshill presented a petition to Parliament, in which they prayed for assistance towards establishing a school of design as connected with the ribbon manufacture. I think the operative weavers would eagerly avail themselves of such means of improving their taste and knowledge of art, if those means could be afforded; and I may mention, as an instance of that, that I was conversing one day with a weaver in Foleshill, and stating to him my wish to see the establishment of some school of design in that neighborhood; he said it would be a good thing, and the next morning his nephew waited upon me; he said his uncle had mentioned our conversation to him, and he very much wished that something of the sort should be established. He brought with him some patterns which he had made himself, and was anxious that I should assist in setting on foot something of the sort in Foleshill; a register of patterns; or, in short, to establish a school of design. A mere drawing school would be of very little use, unless it was accompanied by lectures on the art of drawing and design as applicable to manufactures, and as showing the means of transferring the design to the article to be produced.

Are you aware, that, at present, new patterns are invented at Coventry and at Foleshill?—I think very few original patterns are invented; but not being a manufacturer myself, I cannot speak very accurately to that.

You have stated that there is a conviction on the part of the operative weavers that such establishments would be of utility to them?—Yes.

There is a willingness, therefore, on their part, to improve their taste and to acquire a greater knowledge of the arts?—Certainly.

Do you conceive there is any want of native talent, if properly encouraged?—None at all.

In fact, then, in your opinion, it is only doing justice to the natural talents of the manufacturing population to give them the means of acquiring a better knowledge of the art of design?—Certainly.

Do you think, if some encouragement were given by government, or by Parliament, for the establishment of schools of art in certain districts, that local assistance might also be obtained for the same object?—Yes, I think so, certainly.

You think there would be no unwillingness to assist, on the part of the inhabitants of those districts?—I think there would be great willingness.

Have you any public collection of pictures at Coventry or Foleshill?—No, there is none at Coventry, and Foleshill is a mere village, with very few opulent inhabitants.

Then the manufacturing artist has no external means of acquiring a taste in the art of painting?—No.

Is there any museum for patterns at Coventry?—No.

Or of machines?—No.

Is botany a study at all attended to by the manufacturing weavers?—No; there are some collections of natural history, principally of birds, at Coventry; but I have not heard that they have turned their attention to botany at all.

Have they any means of acquiring a knowledge of the effect of a combination of colors?—No.

Is chemistry a science which is at all attended to by the operative weavers?—No.

Is it not attended to by the dyers?—I do not know.

In your opinion is there a sufficient number of opulent inhabitants in Foleshill to establish institutions to promote instruction in the arts among the manufacturing population?—At Coventry, I think, very material assistance could be derived, not only from the opulent inhabitants, but from the established school of that place. There is a school called Bablake School, which is under the patronage of the corporation, in which I think drawing and design, as applicable to manufactures, might very easily be introduced. I think the funds at the disposal of government would very much assist, with the aid of the local institutions, such as Bablake School, in which, if the boys could be taught the arts connected with the occupations in which they are afterwards to be engaged, it would be very advantageous. A central school of art for the instruction of teachers would be very useful, as it would provide for a general direction of the schools. The instructors, taught in London, from the circumstances of the immensity of the population, the number of public galleries, and the habitual intercourse that exists among individuals of all nations, would certainly have superior facilities for acquiring knowledge in all branches of art.

Mr. Robert Butt, of the Bronze and Porcelain Department, at Messrs. Howell and James, examined:

I consider, that, with a few exceptions, in metallic manufactures the French are vastly superior to us in their designs. The exceptions to which I allude are more particularly to manufactures in silver, to gold, jewellery, and to castings in iron, in which I think we excel them in design. In some branches of the porcelain manufacture the French are superior to us in design, in others they are inferior. In that description of porcelain which is of the same nature as the old Dresden china, ornamented with raised flowers, we are vastly superior to them, and a considerable quantity of such porcelain is, I believe, annually exported to Paris, and is sold there, and considered by the French superior to their own; but with the exception of porcelain in which the designs are in relief, theirs are superior to ours. The French are superior to us in their designs in bronzes, and some other metallic manufactures. In the term "bronze," we include not only that which is strictly bronze, but all articles cast in similar metal, whether gilt, or-molu, or otherwise,

such as human figures, figures of animals, and the ornaments of clocks, candelabra, and so on. The superiority of the English in the one case, and the superiority of the French in the other, is accounted for by the superior costliness of the articles to which I allude in England, as compared with those of France, enabling English manufacturers to give high prices to artists to model or design their patterns, particularly in silver; but with respect to articles of an inferior value, the French are superior to us in their designs, from the greater cheapness of art in that country. In the less costly articles for which art cannot be so highly paid, there is not a sufficient supply of art at a cheap rate for the purposes of the manufacturer. For instance, a silversmith who pays highly for a design, and produces a very costly article, could afford to go to a Flaxman or a Stothard, as artists who could furnish a design; but the manufacturer of articles which come within the range of the less opulent classes of consumers could not afford to employ them. Articles in bronze are of sufficient importance to require the employment of able designers, yet they are not of sufficient importance to demand the assistance of art to be paid for at the same rate as it is for manufactures in silver and such costly materials. I mean particularly to allude to the richer description of silver articles manufactured in England. But similar designs for bronze may be obtained at a much lower rate in France. The reason the iron manufactures will pay for the employment of able designers, and those in bronze will not, is because castings in iron, such as I allude to, that is, for architectural embellishment, have a very extensive sale in this country, and we have no foreign competitors in that branch of manufacture, but for bronzes there is not an extensive sale, and we have the competition of the French to contend with. I attribute the general excellence of the French in the design of manufactures to the facilities afforded to persons of all classes in France for acquiring a knowledge of the art of design, and the corresponding difficulty to any but persons of comparative independence of obtaining similar instruction in England. The advantage which arises to the French workman from that knowledge of the art of design which the public institutions of France enable him to obtain, consists in the circumstance that he is thereby enabled frequently to make his own designs and models, and if not sufficiently instructed to do that, he is at all events enabled to finish works executed from the models of others with superior accuracy, so to give them their proper articulation and feeling, particularly in human figures and figures of animals. I may say, in continuation, that this is rarely the case with English workmen; and the advantages which the former consequently possess, are conspicuous in the beautiful figures which decorate the clocks, candelabra, vases, &c., which are imported from the continent, the grace and expression of which (however well modelled by the artist) would be entirely spoiled by an injudicious finishing of the muscles, draperies and extremities, by an ignorant workman. Independently of the workmen being instructed, the manufacturer is enabled to get models of great beauty executed at a reasonable rate, which is one of the causes of the great abundance of beautiful designs in France. I am inclined to think that the opportunities which the French have of studying the arts must give a certain tone and feeling for them throughout the country; but I do not know that any superiority in that respect exists among the middle class of France as compared with the same class in England. With respect to the upper classes, I do not think the arts can be appreciated in any country more fully than they are in England. There are very good works in silver filagree executed in this country; as good as Spanish or American, but inferior to the Indian. There is no considerable importation of silver filagree-work for sale. With respect to Germany, the natives are inferior to the French in design, as inferior as we are, or more so, with the exception of the iron works at Berlin. For putting the English manufacturer on an equal footing with the French, I would recommend the establishment of schools of design on a popular plan, which shall be entirely separate and distinct in constitution and management from any of the academies of painting and sculpture now existing in England; and in which it should be distinctly understood that the system of instruction to be pursued would not be intended to qualify the pupils for the professions of painting or sculpture, but merely to teach them the arts of designing and modelling with purity and taste, to be after-

wards applied to any manufactures which they may themselves practice, or for the direction of the works of others. Such schools would operate to improve the manufacturing artist, by enabling young men to acquire a sufficient knowledge of the art of design, to qualify them for the double capacity of clerks and draftsmen or modellers in the counting-houses of manufacturers, who would thereby be enabled frequently to vary and improve the designs of their manufactures without much cost; the great expense of models and drawings by artists being one of the causes of the paucity of design in their patterns at present. I would observe here, that a parallel system obtains in the offices of architects and engineers, where young men are constantly employed in the capacity of clerks and draftsmen. Having gone through a certain probationary study, they are admitted as articled clerks until they acquire a thorough knowledge of their art, and after a certain time receive payment for their services. It would also enable apprentices in certain trades to acquire a knowledge of design, by agreement in their indentures to attend so many times per week at these schools, so that the study of the manipulation of their trades and the art of design might go hand-in-hand and bring both to perfection. I believe that this system is practised in France. The process by which a knowledge of the arts of painting and sculpture is now acquired in England is this: a young man receives tuition from a private master; he draws from the antique at the British Museum for a certain time, and when he shows that he has sufficient talent to qualify him for a student of the Royal Academy, he is admitted: but the expense of acquiring that preliminary knowledge is considerable, and the young artist must also be maintained by his relatives during the time that he is acquiring it. Open exhibitions of the finest works of all sorts in stone, paintings, bronze, and so on, would have a good effect on manufacturing artists, as giving specimens of the highest works of art. Every school ought to have its museum, the expense of the formation of which would not be great, for casts from the antique statues, busts, vases, candelabra, gems, coins, and so on, would answer the purpose very well. Such a museum ought to be open to the public under certain limitations, to prevent their interfering with the studies of the scholars. There can be no doubt that it would be of the greatest benefit to the manufactures of this country, by improving the taste of minor artists and workmen. The Acts of Parliament existing, for the security of copyright, as far as I know, on the subject of copyright in models or casts from models, afford protection to a certain extent, but the objection is, that they do not go far enough; the protection afforded by the law to models or casts in bronze and other metals extends only to such designs as represent human figures, or figures of animals, or part or parts of such figures. I may state, for example, that however beautiful the design may be, if it be merely a model of *Arabesque* scrolls or foliage of any description introduced into any work, such as clocks, candelabra, &c., there is no protection for it; it may be pirated with impunity.

The copyright in articles which the law now protects, is, in the first place, for a term of fourteen years, and for a further term of fourteen years in case the inventor be still living at the expiration of the first term, and has not sold his copyright. That is the law at present under the Acts of the 38 George III. chapter 71, and the 54 George III. chapter 56. By the last Act the protection given by the 38 George III. to models of human figures or of animals, was extended to human figures clothed in drapery or otherwise, and combinations of the human figure with parts of the figures of animals, and also to any subject being matter of invention in sculpture. It is very difficult to ascertain the true construction to be put upon the words "being matter of invention in sculpture," but my opinion is, that they would not extend to guarantee the copyright of any model or scroll work, &c., cast in metal, as in the instance of the iron gates of the royal entrance to Buckingham Palace at Hyde Park Corner, which are remarkably beautiful. Now, I apprehend that if casts or impressions were to be clandestinely taken from those gates, and another pair similar in all respects, but with the omission of the royal arms, were to be thereby made and sold, and the proprietors of the model were to bring an action for the piracy, it would be contended that there was no copyright in the design, as it would not consist of models of any part of the human figure or the figure of animals. Moreover, as it

could be easily proved that the models of those gates were originally made in wax, clay, or some plastic material, and then cast by the founder in iron, it would be held that there was no sculpture in the matter, and that therefore they could not come within the meaning of the words "matter of invention in sculpture." They might be imitated, provided the King's Arms, which, of course, contains representations of animals, were omitted. This imperfection of the law applies to the proprietor of the model, whether he be the artist, or whether he has purchased it from the artist. By the copyright of a model is of course understood the exclusive privilege of making copies or casts from that model, which a manufacturer may purchase from the artist. The inventor of models which come within the Acts of Parliament as representing human figures or figures of animals, is, I think, sufficiently protected by the present law. I do not consider that the present copyright is for too long a period with a view to afford the inventor a fair protection, and at the same time with a view to the interests of the public, because articles of the nature of which I have been speaking do not sell rapidly; at first the manufacturer will sell but few, and it is only when they become known that he is repaid for his outlay. A provision ought to be made to protect the copyright of models in cases not of an exact copy, but of so near an imitation that one might sell as well as the other; for instance, a figure of Apollo, by altering the posture in the slightest degree, or putting a different drapery upon it. With regard to designs in jewellery, the observation I made as to the additional costliness of articles of silver extend also to jewellery; in England, our designs in jewellery are superior to the French designs. In this case, the manufacturer is frequently his own designer. I attribute the superiority of the English in designs of jewellery to the superior encouragement afforded in England to the manufacture of expensive articles in gold jewellery. In imitative jewellery, however, the French excel us, for there is greater encouragement in France for the inferior classes of ornaments than there is for the real; the propriety of the distinction that I draw between the qualities of the real and imitative jewellery of the two countries may be inferred from the circumstance, that immense quantities of gilt jewellery are annually imported from France, and but little or none in gold.

Mr. Charles Harriott Smith, Sculptor of Architectural Ornaments, examined:

My profession relates to the decoration of buildings; the exterior in stone, and the interior in marble; particularly such work as that about the exterior of the new National Gallery, on which I am now occupied; it is that particular department which I principally profess. The capitals and other ornaments, small monuments for churches, ornamentedc himney-pieces, &c. There is no difficulty in finding useful assistants, provided I can afford to give them a fair remuneration. The ordinary wages of a clever person, according to his abilities, about 2*l.* or 3*l.* per week. I design myself, but I work a great deal under the direction of architects from their designs. There are no national schools where students can obtain instruction; a few private academies. I have always found workmen who can draw, if ever so little, are more useful, and have the preference. I was going to mention a case in point, that recently occurred to me; I sent my foreman into Yorkshire with work; on his arrival, he found difficulties arose which he had not, nor had I anticipated, and by letter to me, illustrated by his sketches, he explained all that I could wish for. No one but a man conversant with drawings could have done that; similar circumstances are likely to occur to any man in business; and such men obtain, in consequence, higher wages. The workmen have gradually improved, which I attribute to good practice and emulation among themselves; also, the opportunity of seeing works of art, and the opportunity of practising upon works that are likely to improve them. The public demand for architectural ornaments increases, especially in my department. We are most deficient in the true spirit of the Gothic or old English style of carving; but what is strictly called architectural ornaments are more particularly a mechanical process, such as Corinthian and other capitals, friezes of regular proportional parts, &c.; but where trophies, draperies, and those sorts of things occur, they become more decidedly connected with the fine arts. The workmen are, of course, less skilful in that branch than the mere execution of the mechanical part, such as the capitals of

Corinthian columns, because it approaches nearer to a work of fine art, and hence becomes more difficult to execute. Wages increase pretty much in the proportion in which the operative is removed from mechanical labor towards the production of art; those branches that are purely mechanical, and depend much on accuracy of measurement, such as the execution of Corinthian capitals, are done by ingenious common workmen, if I may so term them; when they are employed on work nearly approaching to fine art, which requires more study and mental comprehension, of course the men have better practice, and if they succeed, they demand higher wages, and are entitled to it. I think, that simply in consequence of the improved habits of artisans in my branch of art, it is desirable to give them further means of improvement, since their tendency is to a greater degree of refinement, and that they deserve encouragement by instruction, and opening public places of resort, where they will be made familiar with works of art. I have heard them express a wish to that effect. I have frequently heard them complain of impediments in the way of seeing works of art; and that the museums and exhibitions are not opened after their working hours, and that they have no opportunity of going to them, without not only having to pay for admission, but to lose their time, and of course it thus costs them much more than it does persons in easier circumstances. I think it would be desirable that those collections of works of art, whose influence upon the laboring population would be so beneficial, should be accessible to them at times when they could be visited without any great pecuniary sacrifice on their part. I have always considered that the best means of serving the industrious classes, is to increase their means of serving themselves. I have visited most of the museums in France, and I do not think them superior in designing. The French are more aware of the importance of employing artists to design for their manufactures than the English are. What I have observed as to the comparative merits of the same description of works in the two countries, is this: I think ornaments are as well designed in England as in any country, but the French workmen, collectively, are better educated in art than the English workmen; consequently the French artist has a greater facility of getting his designs well executed than the English artist. The French people, as a body, seem not to be so satisfied with inferior performances as the English are. Whatever deficiency of taste is displayed in our manufactures, arises not so much from want of taste in artists to design and in our workmen to execute, as it does from want of study and education in the arts among proprietors and conductors of establishments wherein classical design and execution forms an important feature. I am also of opinion, that the public, as a body, are not yet sufficiently educated in the arts to discriminate between pure classical elegance and meretricious finery. I am alluding to the public as a body in this country; and the dealers' study is not so much to improve the taste of the public, as to discover what goods will sell most readily, and produce them the largest profit. To mention instances in which our manufacturers giving employment to artists—Coade and Sealey, the artificial stone-manufacturers, formerly employed some of our most eminent sculptors; among others, the elder Bacon, and Rossi; Rundle and Bridge, the silversmiths, used to employ Flaxman, Stothard, Theed, and Baily, all of whom were eminent in the arts, to design and model for them. Wedgewood used to employ artists of eminence also. At the time they employed these artists they were doing an amazing portion of business. From what cause I do not say, but most of those establishments have changed their system of employing artists of eminence, and they have since employed inferior artists, of course at a much less expense. Whether that is the cause or not, I cannot undertake to say, but their business has certainly fallen off very much; they have now comparatively little or no business of any kind wherein the highest class of artists had been engaged, and the plan appeared to produce the most beneficial results to the proprietors. Works of art are not sufficiently protected, especially those departments of art which are more immediately connected with our manufactures; I mean that which I profess. There is a constant piracy going on, and in my own practice I may allude to it more particularly. It is impossible to protect myself sufficiently from it. Any original drawings or models, whenever I am out of the way, are liable, by workmen or others,

to be pirated, and I have no remedy beyond that of discharging an otherwise valuable workman The copyright of the sculptor, the 38 and 54 of George III., is understood in general not to include ornamental works of architecture; but if a case were to be tried, it would very likely take in all classes of sculpture; but the chance of recovering is too doubtful and expensive. I believe it never has been tried.

(To be continued.)

The following article gives the best general description we have seen of the "Application of the Hot Blast." It is well worth reading.

From the London Mechanic's Magazine.

ON THE APPLICATION OF THE HOT BLAST IN THE MANUFACTURE OF CAST-IRON.

BY THOMAS CLARKE, M. D., PROFESSOR OF CHEMISTRY IN MARISCHALL COLLEGE, ABERDEEN.

(Read before the Royal Society of Edinburgh, March, 1835.)

Among persons interesting themselves in the progress of British manufactures, it can scarce fail to be known, that Mr. Neilson of Glasgow, manager of the Gas-Works in that city, has taken out a patent for an important improvement in the working of such furnaces as, in the language of the patent, "are supplied with air by means of bellows, or other blowing apparatus." In Scotland Mr. Neilson's invention has been extensively applied to the making of cast-iron, insomuch that there is only one Scotch iron-work where the invention is not in use, and in that work apparatus is under construction to put the invention into operation. Apart from the obvious importance of any considerable improvement in the manufacture of so valuable a product as cast-iron, the invention of Mr. Neilson would merit attention, were it only for the singular extent of the improvement effected, compared with the apparent simplicity—I had almost said inadequacy—of the means employed. Having, therefore, by the liberallity of Mr. Dunlop, proprietor of the Clyde Iron Works, where Mr. Neilson's invention was first put into operation, obtained full and free access to all information regarding the results of trials of the inventions in those works, on the large scale of manufacture, I cannot help thinking that an authentic notice of these results, together with an attempt to explain the cause of them, will prove acceptable to the Royal Society of Edinburgh. And that these results, as well as the cause of them, may be set forth with clearness, I shall advert

1st. To the process of making iron, as formerly practised.

2d. To Mr. Neilson's alteration on that process.

3d. To the effect of that alteration.

4th. To the cause of that effect.

I. In proceeding to advert to the process of making cast-iron, as formerly practised, it cannot here be necessary to enter into much detail in explanation of a process, long practised and extensively known, as this has been; nor, indeed, shall I enter into detail, farther than, to the general scientific reader, may be proper to elucidate Mr. Neilson's invention.

In making cast-iron, then, the materials made use of were three—

The ore,
The fuel,
The flux.

The ore was clay iron-stone, that is to say, carbonate of iron, mixed, in variable proportions, with carbonates of lime, and of magnesia, as well as with aluminous and siliceous matter.

The fuel made use of at Clyde Iron Works, and in Scotland generally, was coke, derived from splint coal. During its conversion into coke, this coal underwent a loss of 55 parts in the 100, leaving 45 of coke. The advantage of this previous conversion consisted in the higher temperature produced by the combustion of the coke, in consequence of none of the resulting heat disappearing in the latent form, in the vapors arising from the coal, during its conversion into coke.

The flux was common lime-stone, which was employed to act upon the aluminous and siliceous impurities of the ore, so as to produce a mixture more easy to melt than any of the materials of which it was made up, just as an alloy of tin and lead serves as a solder, the resulting alloy being more easy to melt than either the lead or the tin apart.

These three materials—the ore, the fuel, and the flux—were put into the furnace, near the top, in a state of mixture. The

only other material supplied was air, which was driven into the furnace by pipes from blowing apparatus, and it entered the furnace by nozzles, sometimes on two opposite sides of the furnace, sometimes on three, and sometimes, but rarely, on four. The air supplied in this manner, entered near the bottom of the furnace, at about 40 feet from the top, where the solid materials were put in. The furnace, in shape, consisted, at the middle part, of the frustrums of two cones, having a horizontal base common to both, and the other and smaller ends of each prolonged into cylinders, which constituted the top and bottom of the furnace, as may be well enough conceived from the sectional sketch on the margin.

The whole of the materials put into the furnace, resolved themselves into gaseous products, and into liquid products. The gaseous products, escaping invisible at the top, included all the carbonaceous matter of the coke, probably in the form of carbonic acid, except only the small portion of carbon retained by the cast-iron. The liquid products were collected in the cylindrical reservoir, constituting the bottom of the furnace, and there divided themselves into two portions, the lower and heavier being the melted cast-iron, and the upper and lighter being the melted slag, resulting from the action of the fixed portion of the flux upon the fixed impurities of the fuel and of the ore.

II. Thus much being understood in regard to the process of making cast-iron, as formerly practised, we are now prepared for the statement of Mr. Neilson's improvement.

This improvement consists essentially in heating the air in its passage from the blowing apparatus to the furnace. The heating has hitherto been effected by making the air pass through cast-iron vessels, kept at a red heat. In the specification of the patent, Mr. Neilson states, that no particular form of heating apparatus is essential to obtaining the beneficial effect of his invention; and, out of many forms that have been tried, experience does not seem to have yet decided which is best. At Clyde Iron Works, the most beneficial of the results that I shall have occasion to state, were obtained by the obvious expedient of keeping red-hot the cast-iron cylindrical pipes, conveying the air from the blowing apparatus to the furnace.

III. Such being the simple nature of Mr. Neilson's invention, I now proceed to state the effect of its application.

During the first six months of the year 1829, when all the cast-iron in Clyde Iron Works was made by means of the cold blast, a single ton of cast-iron required for fuel to reduce it, 8 tons 1¼ cwt. of coal, converted into coke. During the first six months of the following year, while the air was heated to near 300° Fahr., one ton of cast-iron required 5 tons 3¼ cwt. of coal, converted into coke.

The saving amounts to 2 tons 18 cwt. on the making of one ton of cast-iron; but from that saving comes to be deducted the coals used in heating the air, which were nearly 8 cwt. The nett saving thus was 2½ tons of coal on a single ton of cast-iron. But during that year, 1830, the air was heated no higher than 300° Fahr. The great success, however, of those trials, encouraged Mr. Dunlop, and other iron-masters, to try the effect of a still higher temperature. Nor were their expectations disappointed. The saving of coal was greatly increased, insomuch, that about the beginning of 1831, Mr. Dixon, proprietor of Calder Iron Works, felt himself encouraged to attempt the substitution of raw coal for the coke before in use. Proceeding on the ascertained advantages of the hot blast, the attempt was entirely successful; and, since that period, the use of raw coal has extended so far as to be adopted in the majority of the Scotch iron works. The temperature of the air under blast had now been raised so as to melt lead, and sometimes zinc, and therefore was above 600° Fahr., instead of being only 300°, as in the year 1830.

The furnace had now become so much elevated in temperature, as to require, around the nozzle of the blow-pipes, a precaution borrowed from the finery-furnaces, wherein cast-iron is converted into malleable, but seldom or never employed where cast-iron is made by means of the cold blast. What is called the *tweer*, is the opening in the furnace to admit the nozzle of the blow-pipe. This opening is of a round funnel shape, tapering inwards, and it used always to have a cast-iron lining, to protect the other building materials, and to

afford them support. This cast-iron lining was just a tapering tube, nearly of the shape of the blow-pipe, but large enough to admit it freely. Now, under the changes I have been describing, the temperature of the furnace became so hot near the nozzles, as to risk the melting of the cast-iron lining, which, being essential to the *tweer*, is itself commonly called by that name. To prevent such an accident, an old invention, called the *water-tweer*, was made available. The peculiarity of this tweer consists in the cast-iron lining already described being cast hollow instead of solid, so as to contain water within, and water is kept there continually changing as it heats, by means of one pipe to admit the water cold, and another to let the water escape when heated.*

During the first six months of the year 1833, when all these changes had been fully brought into operatien, one ton of cast-iron was made by means of 2 tons 5¼ cwt. of coal, which had not previously to be converted into coke. Adding to this 8 cwt. of coal for heating, we have 2 tons 13¼ cwt. of coal required to make a ton of iron; whereas, in 1829, when the cold blast was in operation, 8 tons 1¼ cwt. of coal had to be used. This being almost exactly three times as much, we have, from the change of the cold blast to the hot, combined with the use of coal instead of coke, *three times as much iron made from any given weight of splint coal.*

During the three successive periods that have been specified, the same blowing apparatus was in use; and not the least remarkable effect of Mr. Neilson's invention, has been the increased efficacy of a given quantity of air in the production of iron. The furnaces at Clyde Iron Works, which were at first three, have been increased to four, and, the blast machinery being still the same, the following were the successive weekly products of iron during the periods already named, and the successive weekly consumpt of fuel put into the furnace, apart from what was used in heating the blast:—

	Tons.		Tons.		Tons.	
In 1829, from 3 furnaces,	111	Iron from	403	Coke, from	888	Coal.
In 1830, from 3 furnaces,	162	Iron from	376	Coke, from	836	Coal.
In 1833, from 4 furnaces,	245	Iron		from	554	Coal.

Comparing the product of 1829 with the product of 1833, it will be observed that the blast, in consequence of being heated, has reduced more than double the quantity of iron. The fuel consumed in these two periods we cannot compare, since, in the former coke was burned, and in the latter coal. But on comparing the consumpt of coke in the years 1829 and 1830, we find that although the product of iron in the latter period was increased, yet the consumpt of coke was rather diminished. Hence the increased efficacy of the blast appears to be not greater than was to be expected, from the diminished fuel that had become necessary to smelt a given quantity of iron.

On the whole, then, the application of the hot blast has caused the same fuel to reduce three times as much iron as before, and the same blast twice as much as before.

The proportion of the flux required to reduce a given weight of the ore, has also been diminished. The amount of this diminution, and other particulars, interesting to practical persons, will appear on reference to a tabular statement supplied by Mr. Dunlop, and printed as an appendix to this paper. Not further to dwell on such details, I proceed to the last division of this paper, which is,—

IV. To attempt an explanation of the foregoing extraordinary results.

Subsidiary to this attempt, it is necessary to discriminate between the quantity of fuel consumed, and the temperature produced. For instance, we may conceive a stove to be kept at the temperature of 500° Fahr., and lead to be put into such a stove for the purpose of being melted. Then, since the melting point of lead is more than 100° higher, it is evident that whatever fuel might be consumed in keeping that stove at the temperature of 500°, the fuel is all consumed

* An incidental advantage attended the adoption of the water-tweers, inasmuch as these made it practicable to lute up the space between the blow-pipe nozzle and the tweers, and thus prevent the loss of some air that formerly escaped by that space, and kept up a bellowing hiss, which, happily, is now no longer heard.

to no purpose, so far as regards the melting of lead, in consequence of deficiency in the temperature. In the manufacture of cast-iron likewise, experience has taught us, that a certain temperature is required in order to work the furnace favorably, and all the fuel consumed, so as to produce any lower degree of temperature, is fuel consumed in vain. And how the hot blast serves to increase the temperature of a blast furnace, will appear on adverting to the relative weights of the solid and of the gaseous materials made use of in the reduction of iron.

As nearly as may be, a furnace, as wrought at Clyde Iron Works in 1833, had two tons of solid materials an hour put in at the top, and this supply of two tons an hour was continued for 23 hours a-day, one half hour every morning, and another every evening, being consumed in letting off the iron made. But the gaseous material—the hot air—what might be the weight of it? This can easily be ascertained thus; I find, by comparing the quantities of air consumed at Clyde Iron Works, and at Calder Iron Works, that one furnace requires of hot air from 2,500 to 3,000 cubical feet in a minute. I shall here assume 2,867 cubical feet to be the quantity; a number that I adopt for the sake of simplicity. inasmuch as, calculated at an avoirdupois ounce and a quarter, which is the weight of a cubical foot air at 50° Fahr., these correspond precisely with 2 cwt. of air a minute, or *six tons an hour*. Two tons of solid material an hour, put in at the top of the furnace, can scarce hurtfully affect the temperature of the furnace, at least in the hottest part of it, which must be far down, and where the iron, besides being reduced to the state of metal, is melted, and the slag too produced. When the fuel put in at the top is coal, I have no doubt that, before it comes to this far-down part of the furnace—the place of its useful activity—the coal has been entirely coked; so that, in regard to the fuel, the new process differs from the old much more in appearance than in essence and reality. But if two tons of solid material an hour, put in at the top, are not likely to affect the temperature of the hottest part of the furnace, can we say the same of six tons of air an hour, forced in at the bottom near that hottest part? The air supplied is intended, no doubt, and answers to support the combustion; but this beneficial effect is, in the case of the cold blast, incidentally counteracted by the cooling power of six tons of air an hour, or 2 cwt. a minute, which, when forced in at the ordinary temperature of the air, cannot be conceived otherwise than as a prodigious refrigeratory passing through the hottest part of the furnace, and repressing its temperature. The expedient of previously heating the blast obviously removes this refrigeratory, leaving the air to act in promoting combustion, without robbing the combustion of any portion of the heat it produces.

Such, I conceive, is the palpable, the adequate, and very simple explanation of the extraordinary advantages derived in the manufacture of cast-iron, from heating the air in its passage from the blowing apparatus to the furnace.

Marischall College, Aberdeen,
Jan. 10, 1835.

APPENDIX.

The blowing-engine has a steam-cylinder of 40 inches diameter, and a blowing-cylinder of 8 feet deep and 80 inches diameter, and goes 18 strokes a minute. The whole power of the engine was exerted in blowing the three furnaces, as well as in blowing the four, and in both cases there were two tweers of 3 inches diameter to each furnace. The pressure of the blast was 2½ lb. to the square inch. The fourth furnace was put into operation after the water-tweers were introduced, and the open spaces round the blow-pipes were closed up by luting. The engine then went less than 18 strokes a minute, in consequence of the too great resistance of the materials contained in the three furnaces to the blast in its passage upwards.

Materials constituting a Charge.

		cwt.	qrs.	lbs.
1829—	Coke,	5	0	0
	Roasted Ironstone,	3	1	14
	Limestone,	0	3	16
1830—	Coke,	5	0	0
	Roasted Ironstone,	5	0	0
	Limestone,	1	1	16
1833—	Coal,	5	0	0
	Roasted Ironstone,	5	0	0
	Limestone,	1	0	0

Table showing the Weight of Cast-Iron produced, and the Average Weight of Coals made use of, in producing a ton of Cast-Iron, at Clyde Iron Works, during the years 1829, 1830, *and* 1833, *the Blowing-engine being the same.*

COKE AND COLD AIR.							COKE AND HEATED AIR.							COAL AND HEATED AIR						
1829	Weekly product of Cast-Iron by three Furnaces.			Average of Coals used to 1 Ton of Cast-Iron.			1830	Weekly product of Cast-Iron by three Furnaces.			Average of Coals used to 1 Ton of Cast-Iron.			1833	Weekly product of Cast-Iron by four Furnaces.			Average of Coals used to 1 Ton of Cast-Iron.		
	T.	C.	Q.	T.	C.	Q.		T.	C.	Q.	T.	C.	Q.		T.	C.	Q.	T.	C.	Q.
Jan. 7	137	16	2	8	12	1	Jan. 6	176	10	2	5	2	2	Jan. 9	375	8	0	2	12	3
14	148	2	0	6	9	2	13	181	12	2	5	0	2	16	267	18	0	2	4	0
21	148	8	2	6	11	3	20	172	5	2	5	0	2	23	270	7	2	2	3	1
28	138	9	2	7	0	2	27	178	7	0	4	19	0	30	250	9	0	2	4	0
Feb. 4	125	13	0	7	12	1	Feb. 3	164	8	0	5	4	0	Feb. 6	265	3	2	2	1	0
11	136	19	0	7	13	1	10	172	12	0	5	4	0	13	202	10	0	2	4	3
18	130	16	2	7	11	3	17	163	9	0	5	9	0	20	257	1	0	2	4	3
25	105	12	2	7	10	0	24	170	1	0	5	3	0	27	264	0	0	2	5	1
Mar. 4	101	8	1	7	17	2	Mar. 3	154	19	0	5	10	3	Mar. 6	234	13	0	2	5	2
11	111	2	0	8	2	2	10	154	16	0	5	9	2	13	238	7	2	2	7	1
18	114	10	2	7	6	2	17	151	8	2	5	9	3	20	205	13	0	2	10	2
25	110	14	0	8	8	1	24	163	17	0	5	5	1	27	217	14	0	2	2	3
Apr. 1	111	4	0	8	7	2	31	163	8	2	5	11	0	Apr. 3	220	7	0	2	14	2
8	107	7	0	8	3	0	Apr. 7	147	10	0	5	7	0	10	280	9	2	2	0	3
15	91	12	2	8	15	0	14	154	9	2	5	2	0	17	304	7	0	1	17	3
22	85	13	0	9	13	0	21	162	4	0	4	19	0	24	248	12	2	2	3	0
29	91	14	2	9	6	2	28	148	12	2	5	4	0	May 1	245	7	2	2	6	0
May 6	92	7	2	8	8	2	May 5	162	10	2	5	2	2	8	200	17	0	2	8	0
13	94	6	0	9	2	1	12	149	13	0	5	3	2	15	246	4	2	2	5	3
July 8	88	4	2	8	16	3	19	162	4	0	5	5	0	22	219	1	2	2	6	0
15	91	13	0	8	5	0	26	165	7	2	4	18	3	29	231	2	0	2	8	0
22	97	2	0	8	2	1	June 2	169	4	0	5	2	2	June 5	235	16	0	2	6	2
29	104	15	2	7	10	2	9	157	17	0	5	1	0	12	232	10	0	2	7	1
Aug. 5	106	17	2	7	7	2	16	164	0	0	4	17	3	19	271	1	2	2	1	0
12	93	1	0	8	6	0	23	149	3	0	4	18	0	26	262	3	2	2	3	0
19	113	7	0	8	18	2	30	162	16	2	4	16	3	¼ w. 30	122	16	0	2	5	1
	2878	18	0	209	19	0		4215	6	0	134	6	2		6370	3	0	58	18	3
Average	110	14	2	8	1	1		162	2	2	5	3	1		245	0	0	2	5	1

The correspondent by whom we have been obligingly favored with the preceding paper, makes himself the following remarks on the subject of which it treats. — Ed. M. M.

"The best application of the hot blast that *I* have yet seen, is at the Wilsonton Iron Works, near Lanark and Whitburn. At these works the heated air is never at a *lower* temperature than the melting point of lead (612°.) This is readily *tested* by inserting a small bar of lead into an opening in the pipe for the purpose, a little way before it enters the furnace; the lead is *instantly* melted. When in good working order, zinc is fused (700°) in the same way. The air is heated in passing through a series of iron pipes of *small* diameter, fixed upright in a brick oven, and kept at a red heat; the heated air entering the furnace by *four tweers*. 'The Condie pipes,'—so called from Mr. John Condie, the manager of the Wilsonton Iron Works, and late of the Calder—last much longer than the ill-arranged heating apparatus (with pipes of large diameter) at the Clyde Iron Works, and effect a much greater saving in fuel.

"The *raw coal* when used as the fuel, has the disadvantage of soon filling the furnace, and is also found to produce an inferior quality of iron, to that made by use of coke. It is, therefore, not unlikely to be soon, generally, given up."

From the London Mechanic's Magazine.

REMARKS ON THE CONSTRUCTION OF BOG-ROADS.

Sir,—There are some instances where vehicles are obliged to run in the same track or rut, either owing to the sloping sides of a road, its inequality, or to facilitate the journey of the horses on account of its being boggy.

In the first case, they run on the crown of the road, consequently in the same rut; and as the traffic increases, the rut becomes greater. The inequalities of a road are a great evil; and when the road is boggy as well, the sides are still more avoided, as the water in running over the sloping sides is absorbed in the yielding substance, and renders passage over them impossible. Ruts cease to exist if the roads are worn equally in every part; therefore, if the roads are perfectly level, or nearly flat, every vehicle will take a separate track. The first thing to be considered in the construction of bog-roads, after the ground is well drained, is the making the surface perfectly level; and after that has been effected, if concrete, similar to what is used in securing the foundations of buildings, and mixed with broken stone, were thrown in, and exposed for a considerable time, it would be superior to any other method previously adopted. When hardened sufficiently for constant use and friction, time alone would soon prove whether it would not be more serviceable and efficacious than either the method of "laying branches of trees on the level of the strata," or "firm heathy sods." When such roads are situated near any place from whence lime may be obtained, or gravel could be had in abundance, additional facilities would be offered for effecting this method, which, as it becomes by exposure as firm as a rock, would certainly be found beneficial. The additional expense attending the construction of such a road, if the work is properly performed, would also be compensated by the permanent and substantial road which would be the result. Yours, &c.

FREDERICK LUSH.

Charles-square, Hoxton, Nov. 20, 1835.

[Some useful hints as to the improvement of our common roads, in similar situations, may be drawn from the foregoing article.—ED. M. M.]

NEW AND IMPORTANT INVENTION.—Among the many useful and scientific discoveries of the day, we are called upon to notice, particularly, one which is said to be of inestimable value and importance. Mr. J. C. F. Salamon, of Pennsylvania, obtained, a few days ago, letters patent from the United States, for a Safety Steam Boiler, so constructed that it would seem almost impossible that any degree of pressure upon it could produce explosion. The philanthropist will receive the glad tidings of this invention as the dawn of a better day for the navigator and merchant, and contemplating the saving of human life and limb from destruction, by the application of this ingenious invention, will hail the inventor as a public benefactor. Every scientific man who has seen the model, we are told, pronounces it unequalled in its importance. We insert an extract of a letter on the subject of the Safety Boiler, written to Mr. Salamon, by one of the most scientific mechanics of our country, and one, too, to whom the public is indebted for several valuable inventions in other branches of machinery:

"Dear Sir—I have taken the liberty of addressing you on the subject of your newly invented Steam Boiler, and I assure you the more I examine the principle and mode of its construction, the more confident I am that in every sense of the word it is preferable to any I have ever seen before, and for strength and durability it cannot be surpassed. It presents a greater surface for the fire to act upon than the common cylinder boiler, and of course less fuel will be required, and from the peculiar construction of the boiler, the heat will act with double the advantage to what it would on a round cylinder boiler. In short, I think, when this principle of yours is fairly tested, it will appear better in practice than in theory. Every man of science will give it the preference. The same weight of metal, I venture to say, cannot be put in any other form to contain as many cubic feet of water and have the same strength. It is my opinion that it will be capable of resisting almost any pressure of steam that can be conceived of."

We understand that the ingenious inventor was not permitted to take out his patent without opposition, a claim of priority of invention having been alleged in behalf of another claimant. Mr. Salamon was, however, enabled to prove an earlier period of publication, and the arbitrators to whom the matters in question were referred, gave their award in favor of him. This circumstance is another evidence of the very great importance of the invention; for even the approval of a plan of machinery by a man of as much science and skill as Col. Humphreys, (the other competitor,) would go far in recommending it to attention.

A full test will, we are informed, soon be made of this invention, and it is boldly predicted that the Safety Steam Boiler will prove itself, if not the first, one of the first and most valuable inventions of the age.—[National Intelligencer.]

VELOCITY OF WATER-WHEELS IN THE NIGHT.—Popular notions must always be a subject of curiosity and interest to philosophical inquirers, whether these notions are founded on observation, or confounded with superstition: and we are not aware that any popular notion is more extensively diffused among millers (though many of them may not believe in it,) than that which ascribes a greater velocity in the night than in the day, to a water-wheel under the same head. Why there should be any difference, none of the believers in this doctrine have even been able satisfactorily to explain. To argue against it has been futile, because early prejudice was stronger than the powers of reason; and therefore no other way remained that could prove effectual, but to bring it to the test of experiment. For this labor we are indebted to Professor Cleaveland. His statement, which follows, is contained in a letter to Professor Silliman, and published in the American Journal of Science and the Arts.

"In a former letter, I mentioned the opinion existing in this part of the country, that saw-mills move faster during the night than the day. The explanation usually given by the workmen is, that the air becomes heavier after sunset.

"I selected a fine day in August, and requested that all the mill-gates might remain stationary for twelve hours. At 2 o'clock P. M., I suspended a barometer in the mill; the pressure of the atmosphere was equal to 30.19 inches; the temperature of the water just before it passed the mill-gate, was 72° Fahr. The log was then detached from the saw, and the number of revolutions of the wheel, being repeatedly counted by different persons, was 96 in a minute. At midnight I again visited the same mill. The barometer stood at 30.26 inches, the *pressure* of the atmosphere having *increased* seven hundreths of an inch. The temperature of the water was 72°, the same as at the preceding observation, although it had been a little higher during the afternoon. The log being detached as before, the wheel was found to revolve precisely 96 times in a minute, showing the same velocity as at the preceding noon. The depth of the water was the same during both experiments. The workmen were satisfied that the result of the experiment was correct, but still they seemed to believe that it would be different in a cloudy night."

GEOLOGICAL SURVEY OF THE STATE.—Agreeably to a resolution of the Assembly of last year, the Secretary of State has made a report in relation to a geological survey of the State. He had been requested to report the most expedient method of obtaining a scientific and perfect account of its rocks, soils, and minerals, and of their localities; a list of all its mineralogical, botanical, and zoological productions, with specimens; and an estimate of the expenses, including the cost of publishing three thousand copies of such report, with drawings and a geological map. We consider it a very able state paper.

The great importance attached to such investigations may be better understood by some of our readers, if we refer to the munificence of STEPHEN VAN RENSSELAER, who employed Professor Eaton, with assistants, four years in making a geological and agricultural survey of the district adjoining the Erie Canal, besides being at the expense of various other examinations of great extent. This was performed twelve or fifteen years ago. Since that time Massachusetts, Tennessee, the two Carolinas, and Maryland, have either caused or directed geological researches to be made within their respective limits; and Virginia, New-Jersey, and Pennsylvania have the subject before them. With these examples in view, we hope "the Empire State" will not prove recreant in the cause of science and practical utility, when her ample means so fully enable her to develope her own resources. The discoveries which her geologists may make, would be only a part of the benefits to be derived from this enterprise. Hundreds of her citizens would be stimulated to make closer observations; and when explorations shall be conducted in the broad light of science, we shall hear but little more of fortunes wasted in searching for minerals, or of the fruitless toils of the miner.

A few years ago £80,000 sterling were expended in searching for coal at Bexhill, in Sussex, England, "when," as Sir J. W. Herschell observes, "every geologist would at once have declared it abortive." "Mr. Townsend informs us," says Malte Brun, "that a pit was sunk for coal to the depth of six hundred fathoms at Bruham, near the chalk hills of Bradley-Nole, and that the miners reached only to the uppermost beds of the great oolite." The history of mining operations in England abounds with such examples. It may be mentioned on the authority of the last writer, that the commissioners of the Bath roads, sent ten miles for flints, while their wagons actually passed, without their knowing it, over a bed of flints for the greater part of the way. The stone of which the Bath Cathedral is built was conveyed from the distance of four miles; it was not then known that the same stone might be obtained in the immediate vicinity; quarries have since been opened. If

errors of a like nature are now less frequently committed—if pits are not so often sunk in vain—it is because *practical men have availed themselves of the discoveries of geologists.*

To these statements we may add the expensive attempt to procure salt water on the south shore of Lake Erie, in the neighborhood of Portland, which any geologist acquainted with *the dip of the strata* would at once have pronounced hopeless.

The Secretary proposes to divide the State into four districts. The *first* to consist of all the counties lying to the south or east of Delaware, Schoharie, Schenectady, and Saratoga, which are also to be included—containing 12,263 square miles. The *second* district to comprise the counties of Warren, Essex, Clinton, Franklin, Hamilton, and St. Lawrence—containing 9,692 square miles. The *third* district to include all the other counties adjoining the Erie Canal and lying north of it, to the west bounds of Genesee and Orleans—containing 12,293 square miles. The *fourth* district is to consist of the remaining (14) counties, which are estimated at 11,594 square miles.

To each of these districts, it is proposed to appoint two geologists and a draughtsman, and one zoologist and one botanist for the whole State, each to be accompanied by a draughtsman. It is supposed that four years will be required to complete the survey; and the whole expense, including that of publication, is estimated at $104,000. A lower estimate, however, has been made on the suggestion of confining the examinations to geology; but we must indulge the hope that our legislators on this occasion will act with a liberality worthy of themselves and of their country.—[Genesee Farmer.]

Railway Phenomenon.—On Monday last a gentleman of this town, who had taken his place in the hindmost carriage of one of the railway trains from Bolton to Kenyon, witnessed the following singular occurrence:—He was placed with his back to the engine, and had a clear view of the receding line of railway. The train was going down the inclined plane from Baglane to Leigh, at the apparent rate of from 30 to 40 miles per hour. A man who was standing on the side of the railway threw a stone about the size of a hen's egg in a horizontal direction, and with considerable violence, at the train. The stone was distinctly seen by the gentleman in its progress to the carriage in which he was seated, and, having attained its maximum of velocity, it appeared, like Mahomet's coffin, to be suspended in the air for a few seconds, within a foot of the gentleman's head. He seized hold of it, and he describes the sensation which he felt in doing so as somewhat similar to that which would be felt in grasping a stone, in a state of rest, suspended by a thread.—[Bolton Chronicle.]—[This is easily accounted for; both the train and the stone had attained the same velocity.—[Manchester Adv.]

Bell Rock Lighthouse.—During the heavy gales of the month of October, the sea, for this early period of the season, broke uncommonly high upon the lighthouse, the foundation of which is immersed to the depth of the full rise at every tide. The light-keepers, in their monthly report (ascertained by the position of the perspective windows of the house) state, that the sea rushed up the walls to the height of from 60 to 70 feet, on the 5th and 6th; to 80 feet on the 11th and 12th; and to 70 feet on the 26th. On these occasions, the green seas collapse the lower part of the building, when sprays, as white as snow, shoot up, and in their fall, as seen from the balcony, produce effects truly sublime. To the mariner, passing at a safe distance from the rock, the lighthouse and its inmates cannot fail to suggest reflections somewhat awful. But habit has so trained the light-keepers to this scene, that it excites no alarm, and in their monthly return, they go on with a detail of having caught a number of the birds which in storms constantly flutter about the light, and sometimes break the plate-glass windows. On the 23d, an immense flock of marrets and other sea birds occupied several hours in passing the lighthouse in their flight from the northward in the direction of the Isle of May, in the Frith of Forth. So uncommonly numerous were they, that it is supposed they must have been turned by stress of weather in their migratory flight.—[Montrose Rev.]

Fossil Tree.—In the quarry from which stones are at present being taken for the new church erecting at the Milton of Balgonie, was lately discovered a large fossil tree. It is lying nearly horizontal, and is as yet attached by about two thirds of its circumference to the sandstone. It is about fifteen inches in diameter, and about seven feet of it are at present visible. As it tapers slowly to the outer end, the portion still undiscovered is probably considerable. It is wholly composed of white sandstone similar to that in which it is imbedded. This quarry is remarkably rich in vegetable impressions. Casts or marks of palm trees are to be found in great beauty and abundance.—[Sunderland Herald.]